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THE U. S. EXPORTS for the fiscal year 1901 seem destined to break all records, and perhaps touch the billion and one-half line, says the Treasury Bureau of Statistics. For the 12 months ending with February, the total is $1,490,194,985; and for the eight months of the fiscal year 1901 this total is $1,015,185,374. The record for the corresponding eight months of the preceding fiscal year was $919,473,471; and $602,666,873 for the first eight months of 1896, showing a gain of more than 50% in five years. The balance of trade, or excess of exports over imports, for the eight months ending with February, is in our favor to the extent of $492,224,904, as compared with $364,219,897 last year, and only $61,472,040 in 1896. The total imports for the period named for 1901 aggregate $522,960,380.

THE HAY-PAUNCEFOTE NICARAGUA SHIP-CANAL treaty, as amended by the U. S. Senate, has been rejected by Great Britain without any counter proposition. The detailed argument on the amendments is not made public, though the tone of the answer is said to be friendly, and simply calls attention to the rights of England under the old Clayton-Bulwer treaty that the U. S. Senate would abrogate. The effect of the British answer is to practically leave things as they were, and the United States will either have to make an entirely new proposition to England or to follow the lead of Senator Morgan and abrogate the Clayton-Bulwer treaty itself.

A LARGE HYDRAULIC DREDGE is to be built for the Canadian government by the Polson Iron Works, of Toronto, and will be used for deepening the channel through Lake St. Peter. The dredge will be 160 ft. in length with 40-ft. beam and the centrifugal pumps will be driven by a 1,200-HP. triple-expansion engine.

THE IMPROVEMENT OF THE PORT OF MONTEvideo is now ordered by the Uruguay Congress, and the contract is let, work to begin April 1, 1901. A French syndicate has secured the contract. It is claimed that the completion of this work will give Montevideo the finest harbor on the Atlantic coast south of Rio de Janeiro, with the whole valley of the Rio de la Plata tributary to it.

THE PORT ROYAL TIMBER DRY DOCK, which cost the government about $1,000,000, including the site, is to be abandoned as not being worth repair, according to Washington accounts. This dock was commenced about ten years ago, and was built of timber. It has given trouble from the start; the entrance was dangerous and not dredged to a proper depth, and warships grounded in the channel; and the sides and bottom of the dock began to fail some time ago owing to faulty design and construction. It is a costly exhibit of the old type of dry-dock construction, in perishable timber; it was "cheap," but not economical, as the result shows.

THE SHEATHING AND COPPERING OF WARSHIPS is condemned by Admiral Bowles and the Naval Board of Construction, and Secretary Long has approved their recommendation that this be omitted from 14 of the ships last authorized. This decision is based upon the fact that this sheathing has been found practically worthless where tried in foreign navies; and the result will be an immediate saving of about $1,250,000 in the cost of the ships effected. The Board of Naval Construction has been disputing over this sheathing for some years, the predecessor of Admiral Bowles favoring sheathing, and Admiral Mellville leading the opposition to sheathing. The Board is now harmonious.

WARSHIPS UNDER CONTRACT, and their percentage of completion at the present time, are made the subject of a special report issued by Admiral Bowles, the new Chief of the Bureau of Construction and Repairs. The list covers 65 vessels, as follows: Nine first-class battleships, four of them from 39 to 90% finished, and the rest not started; six first-class armored cruisers, none commenced; eight protected cruisers, six of them from 15 to 48% completed; four armored monitors, from 47 to 83% finished; 16 torpedo-boat destroyers, all but three from 50 to 98% finished; 15 torpedo boats, all nearly completed, and seven submarine torpedo boats, from 5 to 30% completed.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Illinois Central Ry. at Clay Switch, Ky., on March 15. A misunderstanding of orders resulted in a head-on collision between two freight trains. Three men were killed and three fatally injured.

AN EXPLOSION of the ammonia condenser of the refrigerating apparatus on board the steamship "New York," of the American Line, on March 14, resulted in the death of two men, a steerage passenger and a steward. Many persons were more or less seriously injured by the spreading of the ammonia fumes through the steerage quarters on the saloon deck. On the following day the tail shaft of the port engine broke in two close to the screw. A smooth sea prevailed at the time, allowing the screw to be secured by steel cables, and the remainder of the journey to New York was made with the starboard engine. This is the third accident of the sort that has happened to the "New York" within less than a year.

THE HALSTED ST. LIFT BRIDGE, Chicago, met with an accident on March 15 by the parting of the hoisting cables. Just as the bridge was being raised one or two of the cables broke, and the sudden strain caused the others to break. No great damage was done to the bridge.

A BOILER EXPLOSION occurred in a laundry at 458 W. Madison St., Chicago, on March 11, causing the loss of 9 lives and injuries to over 50 persons. The engineer was among the killed. This following so soon upon the C. & N. W. Ry. boiler explosion has called public attention very strongly to the lack of proper inspection of boilers in Chicago. The official records appear to show that the boiler was last inspected two years ago, since which time repairs have been made, but the owner did not notify the Boiler Inspector, as required by law. The accident is likely to be the cause of some radical changes in the city ordinances.

A BUTTING COLLISION, in which one locomotive landed on top of the other, occurred at White Pigeon, Mich., Feb. 23. The circumstances of the wreck, according to an illustrated description in "The Railway & Engineering Review" of March 9, were very similar to that on the Old Colony R. R. on Jan. 31, 1898 (Eng. News, Feb. 24, 1898). As in the Old Colony accident, one of the engines was pushing a large snow plow, and the other locomotive was pushed up the inclined front of this till it finally came to rest perched on top of the boiler of the other engine. In the White Pigeon wreck, however, a remarkable fact was that the locomotive which "came out on top" was standing still at the head of a long freight train. The other locomotive was pushing a Russell snow-plow at high speed, and the plow was forced right underneath the locomotive and tender of the standing train. Two trainmen inside the snow-plow were killed in the accident, but the engine crews escaped injury. While these accidents are chiefly of interest as a matter of curiosity, a word may not be amiss as to the need of greater care in the movement of snow-plows. Collisions in this service are, unfortunately, only too common. There is too much of a disposition to take chances at a time when the patience and endurance of the operating force have long been strained by the delays due to inclement weather; but there is no time when precaution and strict observance of all checks against errors in train movement orders are more necessary.

TUNNEL BLASTING on the New York Rapid Transit Railway is causing complaints on the part of property owners residing near the line of the tunnel where it passes under the northwest corner of Central Park. The damage done is confined to the two blocks on Central Park West, between 103d and 105th Sts. In these blocks the concussion has broken much window-glass, ceilings have fallen, and bric-a-brac has been knocked down and destroyed. The tunnel is here in solid rock and the shaft nearest to the houses is 65 ft. deep. As the contractors claim to be using every precaution, and as no rock is thrown out of the shaft, Magistrate Cornell, before whom the complaint was made, could only refer the property owners to a higher court for an injunction. A Mrs. Blum, who was sitting at her window, in a house near the tunnel, was knocked over backwards by the concussion and her arm was broken.

A $4,000,000 ENDOWMENT FOR SUPERANNUATED and disabled employes of the Carnegie Co. is established by the letter of Andrew Carnegie, of March 12, to the President of that company. He gives $5,000,000 of the Carnegie Co.'s bonds in trust for the following purposes: The income of $1,000,000 is to maintain the libraries at Braddock, Homestead and Duquesne. The income of $4,000,000 is to be applied as follows: First, to provide for all employes of the company injured in its service, or for those dependent on such employes as are killed. Second, to provide small pensions to those employes who, after long and creditable service with the company, need such aid in their old age, and who make good use of it. Any surplus revenue, after ten years' operation, is to be used in a similar manner for the benefit of workmen in other than the Carnegie Co.'s mills in Allegheny county, commencing with the mills nearest to the works of the company. This fund is to be used, in addition to the sums heretofore appropriated by the Carnegie Co., for such purposes. An annual report is to be made giving an account of the fund and of its distribution; and this report is to be published in two Pittsburg papers and copies are to be posted freely at all the works, so that every employe may know exactly what is being done.

A SANITARY SEWERAGE SYSTEM FOR BALTIMORE, Md., is authorized by a bill introduced in the Maryland legislature at the instance of Mayor Hayes. The bill names five commissioners, including the mayor, under whose direction the sewers would be built.

ONE OF THE TWO INDIANA WATER POLLUTION bills, presented in substance in our issue of Feb. 14, 1901, has become a law. It prohibits the discharge of manufacturing wastes into any stream in the state, without a written permit from the State Board of Health, the permit to be limited as to time.

THE WATER PURIFICATION PLANT for Louisville, Ky., will be built chiefly by local contractors, in accordance with the plans of Mr. Chas. Hermany, M. Am. Soc. C. E., Chief Engineer of the Louisville Water Co. Some of these plans, together with an abstract of the specifications, were published in our issue of Jan. 17, 1901. The awards, so far as announced, are given in the supplement to this issue.

ONE OF THE PHILADELPHIA WATER-SUPPLY contracts, awarded recently to Mr. Daniel J. McNichol, has been enjoined by the court and the temporary injunction has been continued until further notice. The court holds that certain correspondence between Mr. McNichol and the city officials virtually constituted a second bid on the part of the contractor. The action was brought by one of the other bidders, the firm of Kelly & Ryan.

THE WATER IN RESERVOIRS CONTROLLED BY the Metropolitan Water Board was so low up to the early part of March that the board felt called upon to warn the citizens of Boston and vicinity to guard against waste. The board stated that the flow of the Sudbury River for January and February of this year was "one-quarter the average flow, and but little more than one-half the lowest flow for the same period during the 26 years" past. The reservoirs were less than half full, when the notice was issued, but on March 11 there was a rainfall of 2.2 ins. in the Sudbury drainage area, which was a help, but only a small portion of what is needed.

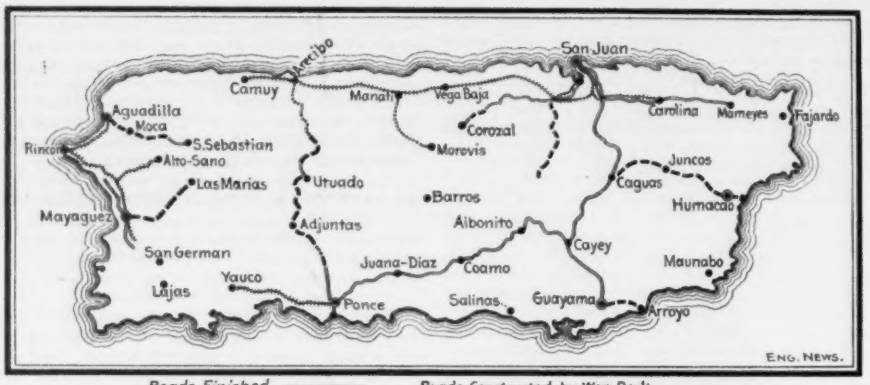
BIDS FOR GARBAGE COLLECTION AND DISPOSAL at Detroit, Mich., were received on March 11, 1901, for terms of 3, 5, 7 and 10 years, respectively, on the basis of collection alone, disposal alone, and the two combined. The lowest bidder for collection was Mr. Jas. Hanley, who offered to do the work for either 3 or 5 years at $31,000 a year and for either 7 or 10 years for $31,775. For disposal the lowest bids were submitted by Mr. J. A. Mercier, his prices being $20,000, $19,000, $18,000 and $17,000 per year for the several terms, shortest to longest. The lowest bids for both collection and disposal were as follows: For the 3, 5 and 7-year periods, respectively, $50,000, $52,000, and $54,000, from Mr. J. A. Mercier; for ten years, $55,000, from the Detroit Sanitary Co., which now has the contract for disposal by the reduction process. Of all the various plans proposed the cheapest would be the award of a ten-year contract to Mr. Hanley for collection, at $31,775 per year, and for disposal to Mr. Mercier, at $17,000 a year, making a total of $48,775 per year. Next in order is a similar combination for seven years at $49,775. Almost as cheap would be the same combination for five years, or else an award to Mr. Mercier for both collection and disposal for three years, the price being $50,000 a year in either case. Mr. J. A. Blades is city controller.

THE CUBA CO., of which Sir W. C. Van Horne is President, has 2,000 men at work on its 400-mile railway connecting Santiago de Cuba and Santa Clara. The longest steel bridge, that across the Rio Canto, will be 700 ft. long. The line will probably be finished by April 1, 1902. There are now in operation 1,157½ miles of railway in Cuba, not including the Cuba Co.'s lines.

ROAD BUILDING AND OTHER PUBLIC WORKS IN PORTO RICO UNDER THE U. S. MILITARY ADMINISTRATION.

(With two-page plate.)

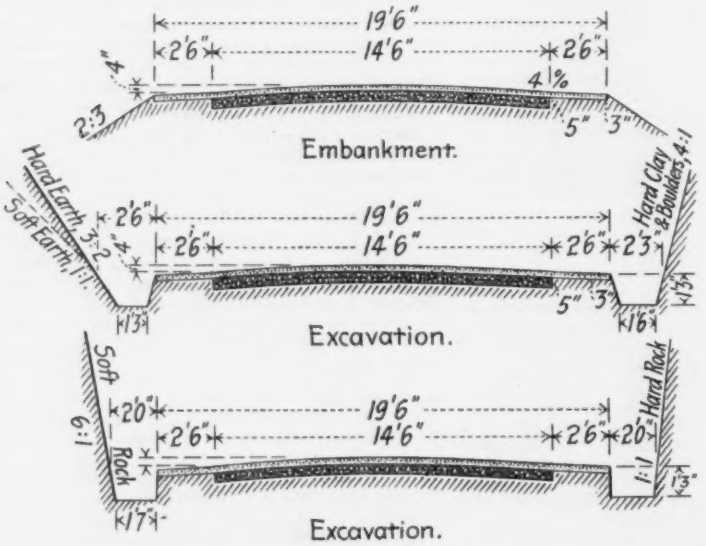
The American occupation of Porto Rico took place on Oct. 18, 1898, and since that date a large amount of public work has been inaugurated and carried out under the military authority of the United States. This work has been performed under the direction of Capt. William V. Judson, Corps of Engineers, U. S. A., and from his several reports to Brig. Gen. George W. Davis, command-

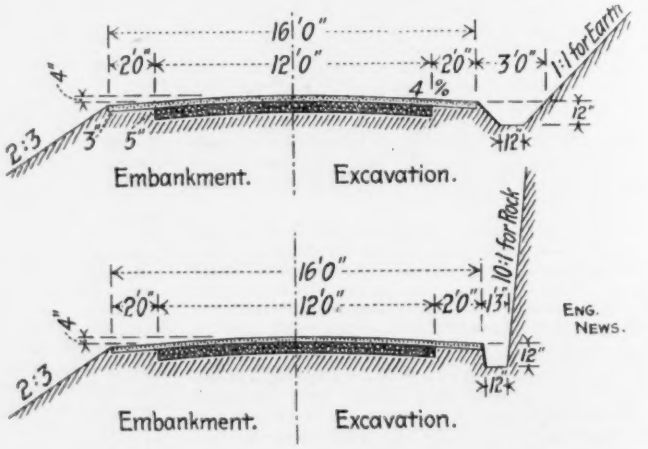


MAP OF PORTO RICO, SHOWING HIGHWAY CONSTRUCTION, JULY, 1900.

ing the Department of Porto Rico, the following abstract showing the extent and character of the work has been prepared.

It should first be noted that from 1875 until shortly before the Spanish-American War, there was a dual administration of public works in Porto Rico; the Provincial Bureau, or the Obras Publicas Provincialos, and the Spanish Colonial Minister, divided the duties and supervision of this work. The Provincial Bureau had charge of certain road work and of certain public buildings, and acted as technical adviser to the local government. But the Ministers' organization, the Jofatura de Obras Publicas, was the more important.





STANDARD ROADBED CROSS-SECTIONS; PORTO RICO HIGHWAYS.

It had certain rights of inspection over the other, and had charge of work on certain roads and public buildings and on lighthouses, and of all technical matters relating to franchises, railways, etc. Local harbor boards were responsible for such work as was done on the harbors at San Juan Ponce and Mayaguez, with certain technical assistance and supervision on the part of the Jofatura. This arrangement was changed by the Canovas law of Dec. 31, 1896; but the short period elapsing between the promulgation of that law and the war did not permit matters to reach any definite stage, so far as the proposed reforms in administration were concerned. The same may be said of the Sagasta laws of Nov. 25, 1897.

When the Americans took possession, on Oct. 18, 1898, the Secretary charged with all the duties pertaining to public works was Dr. Salvador Carbonoll, and his Chief Engineer was Eduardo Cabello; the Secretary was retained by Gen. Brooke, though various changes were made in the Chief Engineer, and the care of lighthouses and harbors was transferred to the U. S. Navy. On May 8, 1899, General Davis took command, and on Aug. 12, the latter, by a general order, reorganized the control of public works. He placed harbor work, lighthouse construction and repairs, maintenance and construction of public roads, bridges and buildings, and all technical matters relating to franchises, railways, etc., under a Board of Public Works, of which Capt. William V. Judson, U. S. Engineer Corps, was the President, and Messrs. F. L. Hills and J. B. Rodriguez were the other members. Mr. Hill resigned Oct. 31, 1899, and was succeeded by Mr. P. F. Fernandez. This Board organized its work under the five sections of roads, public buildings, lighthouses, harbors and accounts; and it subdivided the important section of roads into surveys and field-data, design, construction and maintenance, and put each subdivision under a competent engineer. For the maintenance of roads, the French system was adopted as the one best adapted to the character of the people of Porto Rico, and the engineer in charge of maintenance had under him 3 assistants, 9 overseers, 16 foremen and 95 laborers. Each of the latter cared for 1½ to 2½ miles of completed permanent road.

Porto Rico has an area of about 3,600 sq. miles; and a general coast-line of about 270 miles, along which are scattered the ports of San Juan, Ponce, Arrayo, Humacao and Fajardo, and the lesser ports of Guanica, Naguabo, etc. Lack of land connections multiplied the ports; for, except for a coastal plain averaging a few miles wide, the island is made up of very irregular hills or mountains varying in height from 1,500 to 3,800 ft. These mountains are not in ranges, but are grouped in a very confused manner, so as large to increase the difficulty of road location and construction. The soil erodes very rapidly under t rential rains; steep grades result in ruin to road surface, and very large openings must provided for waterways. Side hill work, to permanent, requires the road to be all in exca tion; if water grades are planned along streams, the amount of rock excavation becom excessive; and if a maximum grade of 7% is to maintained it is difficult to cross the waterways.

On the coastal plain the produce to be transported is sugar, with a maximum length of haul the sea, where it is picked up by small vessels the nearest possible anchorage. Capt. Judson thinks that the land transportation of sugar will eventually be cared for by the growth of the central factory system and by lines of industrial railways to the nearest port. He doubts whether it will be profitable to complete the proposed coast belt line of railway—of which 132 miles are finished. The sea is the cheapest highway between ports. The weight of the annual sugar crop is about 150,000,000 lbs., including molasses, etc. The coffee crop now amounts to about 50,000,000 lbs per year, and the tobacco crop to 6,000,000 lbs. The two last are interior crops, and require an average land haul five to six times that of sugar; and their combined value is perhaps twice that of the sugar.

As a consequence, the American Board of Works has devoted all its energies and funds to the construction and maintenance of roads extending from the principal ports directly into the interior, where such work would have the greatest economic value to the island. Before the Spanish-American War, 158.7 miles of public roads had been completed, at an aggregate cost of $3,484,627. The road across the island, from San Juan to Ponce, was finished in 1888; but since 1874, when about 49 miles of roads were finished, the average rate of construction was only about 4 miles per year.

On Aug 6, 1900, proposals were invited for building roads in Porto Rico; 17 bids were received, and the contract was finally awarded to the Central Contracting Co., of New York. A number of bridges had also to be built, and a study of the conditions in the island led Capt. Judson to adopt two types for highway bridges. One of these, for permanent work, was a concrete-steel arch, and for temporary purposes a low pile-bridge was employed, submergable in the higher floods. The piles were deeply driven and thoroughly braced upstream, and the roadway was loaded with broken stone or concrete. Mr. Edwin Thacher has the contract for erecting two of the concrete-steel bridges, for the sum of $85,121; or the estimated cost, plus 15% for contingencies and profits. One of these, the Jacaguas bridge, is 404 ft. long, in two spans of 100 ft., and one of 120 ft.; the other, the Guayo bridge, is 270 ft. long, in three 70-ft spans.

The report contains a table comparing road construction under Spanish rule with the work un-

dertaken since American occupation. This table does not take into account the large sums spent, since the war, upon reconstruction, country road work, bridges on old roads, etc., work largely resulting from the ravages of the late hurricane. This table is as follows:

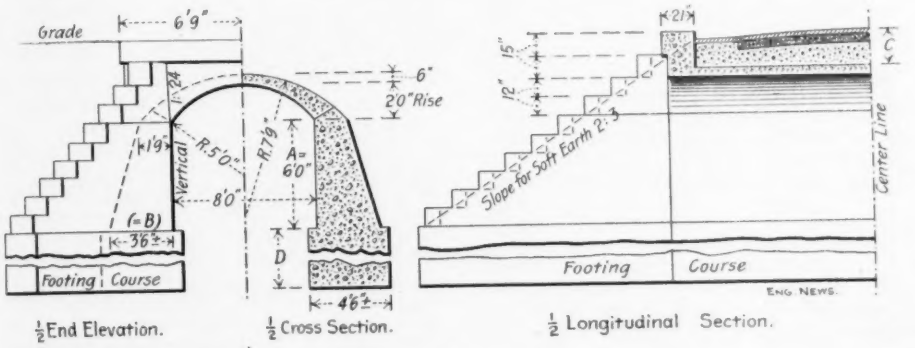
Roads Constructed, or Under Construction in Porto Rico.

Roads.	Constructed before and after military occupation. Before, miles.	After, miles.[1]	Approximate cost.
San Juan to Ponce Playa	82.43	.....	$1,879,340
Catano to Toa Alta	14.88	.....	239,767
Anasco to Pozuela bridge	14.26	.....	202,080
Cayey to Guayama	16.74	.....	615,600
Ponce toward Adjuntas	9.30	.....	152,320
Rio Piedras to Rio Grande	16.12	.....	265,200
Utuado toward Arecibo	3.10	.....	99,000
San Sebastian toward Moca	1.86	.....	31,320
Total	158.72	.....	$3,484,627
Arecibo to Ponce*	39.6	.....	$655,000
El Consumo to Las Marias	7.0	.....	150,000
Aguadilla to San Sebastian*	10.0	.....	93,000
Corazal to Toa Alta	8.0	.....	83,208
Comerio to Bayamon	18.0	.....	270,000
Caguas to Humacao Playa	24.5	.....	425,000
Manati to Ciales and Moravis	12.0	.....	184,000
Guayama to Arroyo	4.0	.....	32,000
Total	123.1	.....	$1,892,208†

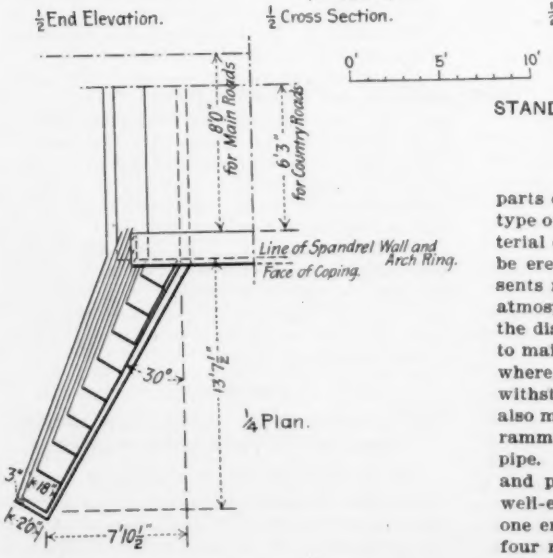
[1]Approximate.
*Omitting portions build before the war and given elsewhere in the table.
†Including money spent or in hand, and including estimates to complete.

CONCRETE-STEEL ARCH BRIDGE; JACAGUAS, PORTO RICO.

LOW-LEVEL PILE BRIDGE OVER PORTUGESE RIVER, PORTO RICO.



½ End Elevation. ½ Cross Section. ½ Longitudinal Section.



STANDARD CONCRETE CULVERT, FOR PORTO RICO HIGHWAYS.

The "Instructions to Engineers," issued by Capt. Judson, are full and explicit. Especial attention is called to the study of drainage areas and the importance of providing very ample cross-section in all culverts, etc., on account of the excessive rainfall. The specifications for macadam road construction call for a bottom course of stone broken to 1¼ to 2½ ins., and 5 ins. deep after rolling; the upper course is to be made of stone broken to 1¼ to ½-in., and 3 ins. deep after rolling. But the Engineer Officer in charge may vary these depths, according to prevailing conditions, or omit one course altogether.

The so-called concrete-steel arch construction calls for steel members imbedded in concrete; the latter made of Portland cement, clean sharp sand and clean broken stone, mixed in the proportions of one part packed cement, two parts sand and four parts of broken stone. Capt. Judson selected this type of bridge for the following reasons: The material can be transported in small packages; it can be erected with the labor of the country; it presents no metallic parts to be rusted by the humid atmosphere of Porto Rico; it is not subjected to the disintegrating action of frost; it costs no more to maintain than an equal length of roadway elsewhere, and its own weight adds to the stability to withstand great floods. The drain-pipe used was also made of concrete laid on an 8-in. bed of ballast rammed to conform to the bottom curve of the pipe. The 30-in. drain-pipe was made 4 ins. thick, and pipes of lesser diameter, 3 ins. thick. Five well-equipped engineering parties took the field; one engaged in boring for bridge foundations, and four making surveys for future construction.

Up to June 30, 1899, appropriations required for public work were made from time to time by the Military Governor; and large sums were expended mainly for the purpose of giving employment to the people who were suffering from the effects of the great hurricane. Out of a total of $420,079, $302,643 were thus expended upon country road improvement. After the Board of Public Works was created, a permanent organization became possible, and the work was systematized. The fiscal budget for the year 1899-1900 was as follows, in its totals:

Road work and public buildings	$527,021
Lighthouse work	82,480
Harbor work	20,772

In connection with the employment, under General Henry, of natives left destitute by the war and the hurricane, the report tells an interesting story of the trials of the first Director of Public Works, Mr. F. L. Hills, and his assistants. As many as 20,000 men were employed at one time on 57 country roads; the island could not provide a sufficient number of qualified engineers, superintendents, overseers, etc., to conduct this work, and there was no time for preliminary study, surveys or plans. These workmen had to be paid every two weeks; they came from a distance, and some only worked a day or two, so that probably 50,000 different men had to be settled with in one month. None of them could write, and they all looked alike to an inexperienced American paymaster, whose language they did not speak and whom they never met in a body. Capt. Judson says that to pay these men presented a greater task than the payment of the entire American army; and he adds that of the four engineers in the organization during this period, two retired with nervous prostration.

The Jacaguas steel-concrete steel bridge referred to is located on a "military road" leading from Ponce to San Juan, and it is built to replace a Spanish all-steel bridge washed away in the hurricane of Aug. 8, 1899. The contract was made under Capt. Judson, as President of the Board of Public Works; but the bridge was constructed with Insular funds, and Capt. Judson's connection with it ceased on May 1, 1900, when the Military Government expired. This was before the arches were started. We give a view of this structure as partly completed, and expect to present further details at a later date. Another photograph shows the Portugese River bridge, a type of the temporary submergable pile-structure, referred to in the report.

The road-map of Porto Rico tells its own story; but to further illustrate the class of road construction adopted, we give "standard plans" for main and country roads, and also a standard cross-section of a concrete culvert, of which many were built in Porto Rico.

SURVEYS FOR A BARGE CANAL ACROSS THE STATE OF NEW YORK.

The New York legislature a year ago appropriated $200,000 to be expended by the State Engineer in making surveys and estimates for a canal from Lake Erie to the Hudson River large enough to accommodate boats of 150 ft. length, 25 ft. beam and 10 ft. draft with a cargo capacity of 1,000 tons. It will be remembered that this is substantially the canal recommended by Governor Roosevelt's advisory committee in 1899 as the best possible waterway for New York to construct along the general route of the Erie Canal.

The report of the results of this survey was presented to Governor Odell by State Engineer Bond on Feb. 12, and some abstract of its contents taken from newspaper statements and more or less incorrect was published in our issue of Feb. 28. We have now before us, however, the complete text of the report, as finally made public on March 14, and what follows is an abstract of its most important features:

ORGANIZATION.

Necessarily the State Engineer, with his numerous official duties, was the executive and not the technical head of the work. To provide for its proper oversight, State Engineer Bond appointed Messrs. Trevor C. Leutze, of Albany, and D. J. Howell, of Washington, D. C., Consulting Engineers, with Mr. Howell as Engineer-in-Charge. Mr. W. B. Landreth was appointed Resident Engineer in charge of the Middle Division and Mr. Jas. J. Overn, Resident Engineer in charge of the Western Division, while Mr. John R. Kaley made estimates for the Champlain Canal.

The instructions to survey parties were submitted to and approved by a special board of engineers, made up as follows: Mr. George S. Greene, of New York city; Mr. George W. Wisner, of Detroit, Mich.; Mr. Edward P. North, New York city; Prof. Palmer C. Ricketts, Troy, N. Y., and Mr. J. Nelson Tubbs, Rochester, N. Y.

LIFT LOCKS.

The ascent of the canal around the falls of the Mohawk River at Cohoes has been one of the most difficult problems to solve.

State Engineer Adams in 1894 advocated a mechanical lift lock at Cohoes and other localities on the Erie Canal, notably Lockport. Although mechanical lift locks of various types are in more or less successful operation in Europe, none have a lift exceeding 60 ft., while that necessary to overcome the falls at Cohoes would be about 121.3 ft. Plans for such a mechanical lift lock at Lockport were made and submitted by Chauncey N. Dutton and adopted by the Canal Board, June 24, 1897. The failure of the $9,000,000 appropriation to complete the contemplated improvement, however, stopped all progress on that work and the contract for that lock was never awarded.

While the successful accomplishment of a mechanical lift at this spot is a very alluring proposition considering what a saving of water would result, on the other hand failure of the machinery, which would involve closing the entire canal, is a serious proposition. State Engineer Bond, therefore, invited other engineers to submit plans. A hydraulic lock was proposed by the Buffalo Engineering Co., and one operated by electricity was submitted by Mr. Wm. R. Davis, chief bridge designer of the State Engineer's office. For the purpose of comparison of cost, plans were also prepared for a series of concrete masonry locks which would overcome the height of the fall by a flight of four locks, each having 30.3 ft. lift.

These various designs were then submitted to a board of advisory engineers, consisting of Hon. Elnathan Sweet, ex-State Engineer and Surveyor, who was made chairman; George S. Morison and Prof. William H. Burr, members of the Isthmian Canal Commission; Majors Thomas W. Symons and Dan C. Kingman, of the Corps of Engineers, U. S. A.

After carefully considering various types of mechanical lift locks and a comparison of the cost of the ordinary masonry locks, it was decided that conservatism demanded the use of the old and tried type rather than a comparatively new and experimental one. This decision was reached partially from the fact that timber gates of the miter type, built of solid beams of Pacific coast fir timber, have been found by practical experience on the Canadian canals to admit of the building of locks of 40 or 50 ft. lift when thought desirable. This type of gate has been in successful operation in Canada for many years, and there is nothing of the nature of an experiment in the adoption of such design. The highest lift used in the plan adopted by the board, however, is 40 ft., on the Lewiston-La Salle line; on the Waterford line 33 ft. is the highest lift.

Later this same Advisory Board, with Mr. Alfred Noble substituted for Major Kingman, passed on other important details in connection with the project.

GENERAL TYPE OF CANAL.

The dimensions of the boats to be accommodated were named in the law and it was decided that these could be met by a prism 75 ft. wide on the bottom with side slopes of 1 on 2 in earth section, and corresponding size in rock section, giving a ratio of prism to loaded boat of 4.75. In the river and lake channels the minimum width is 200 ft. Both the bottom and sides of the canal are to be thoroughly puddled wherever necessary, all embankments have a thick puddle core, all sloping sides are provided with well-constructed wash walls and all vertical walls are made of masonry. Guard locks are provided wherever required, and in the canal sections guard gates are provided at distances apart not exceeding ten miles, so that any section can be shut off for repairs whenever necessary.

The single locks are 328 ft. long between hollow quoins, 28 ft. wide in the clear and for lifts over 8 ft., are fed through a culvert running parallel to the axis of the lock in the lower part of each wall. Smaller feed pipes discharge from these culverts into the lock and are placed from 15 to 20 ft. apart. The opening and shutting of these culverts for filling and emptying is controlled by a valve operated by electricity.

In the flight of locks, all of which are double, the culverts will be controlled by Fontaine lift valves, except the outlet of the lowest one, which will be controlled by a gate of the Stoney type. As a general thing, where enough fall can be obtained the power to operate all machinery will be electricity. This will also be applied to the opening and shutting of the gates, the lighting of the lock at night, and all other work incident to lockage.

All boats are to be propelled by mechanical power and no towpath is provided.

Throughout the canal a full complement of first-class new bridges was provided; and ample provision was made for a water supply sufficient to accommodate a traffic of 10,000,000 tons per annum.

COMPARISON OF ROUTES.

The law also provided that comparative estimates should be made of the cost of various alternative routes, while separate estimates should be made of the cost of deepening the Oswego Canal to 9 ft. and the Champlain Canal to 7 ft. Very extensive surveys and investigations have been made in accordance with this requirement, the most notable being the proposal to go via the Oswego River to Lake Ontario and thence through a short canal to Lake Erie, the proposal to make a slack water navigation in the Mohawk River and the diversion of the canal from the city of Rochester.

A large part of the report is taken up with the comparison of the different routes; but the State Engineer makes no recommendations, preferring to present such facts as will enable the state officials to judge for themselves. It is entirely plain, however, that it is vastly better to make a system of slack-water navigation along the Mohawk and Seneca and Oswego Rivers rather than attempt to enlarge the canal on its present location to the dimensions stated above. The advantage of the canalized river location is seen in the comparative estimate of cost given in the accompanying table.

A still more important change is the proposal to use Lake Ontario as a part of the waterway, and it is found that by this means the cost of the work can be brought even below the estimate made by the Roosevelt advisory committee in 1899. The minimum cost of the proposed barge canal by this route is about $50,000,000, not including the cost of the Champlain Canal improvement.

A common objection to every proposition to make use of Lake Ontario is that time would be lost in locking boats down to that level and then locking them up to the height of Lake Erie. To investigate this, careful calculations were made by Hon. Elnathan Sweet, M. Am. Soc. C. E., and it was found that a round trip between Troy and Buffalo would take 35 to 40 hours less via the Lake route than via the Erie Canal route. In addition to this the maintenance will be much less on this route, as the total length of artificial canal and canalized river is much less. Against this is to be offset the necessity for using more seaworthy barges to make the lake trip than would be necessary on inland waters. If, however, the idea of Major Symons, the originator of the barge canal scheme, is realized, the canal would be chiefly used by vessels built to navigate either on the canal or the lakes, and so avoiding transfer charges at Buffalo. If this is correct the inclusion of Lake Ontario would be no disadvantage.

Estimated Cost of 1,000-ton Barge Canal from the Hudson River to Lake Erie (Including 20% for Portions done in Winter, Assuming Present Canal will not be in Use from Nov. 1 to June 1 During Construction).

Canals.	Routes of canal.	Mohawk-Seneca River.	Mohawk-Oswego River—A—Via Oicott.	Mohawk-Oswego River—B—Via Lewiston.	Present canal route modified.
Erie	Distance, Troy to Buffalo, miles	342.66	338.66	347.57	347.66
	Troy to Buffalo, via Mohawk R. canalized	$72,264,826	.....	.....	.....
	Via present route, modified	.....	.....	.....	$81,578,851
	Via Mohawk River to Three River Point, inclusive, Syracuse harbor*	.....	$46,765,755	$48,984,220	.....
Oswego	Three Rivers Point to Oswego, 12-ft. canal	.....	5,170,129	5,170,129	.....
	Three River Point to Oswego, 9-ft. canal	1,481,012	.....	.....	1,481,012
Champlain	Troy to Whitehall, via Hudson River	4,750,608	4,750,608	4,750,608	.....
	Troy to Whitehall, via present canal	.....	.....	.....	5,787,900
Total cost of Erie, Oswego and Champlain canals.		$78,496,446	$56,686,492	$58,904,957	$88,847,763
Estimated value of abandoned land to be deducted					
On Erie Canal		$1,941,380	$1,953,202	$1,953,202	$1,530,222
On Oswego Canal		.....	2,391	2,391	.....
Champlain Canal		22,620	22,620	22,620	.....
Total cost of three canals, less abandoned lands		$76,532,446	$54,708,279	$56,926,744	$87,317,541

*(Exclusive of Oswego Canal) Oswego to Buffalo.

ESTIMATE FOR COMPLETING THE 9-FT. DEEPENING OF THE ERIE CANAL.

On the submission of the above report to Gov. Odell, the State Engineer was requested in addition to present estimates of the cost of completing the so-called $9,000,000 improvement of the Erie Canal, authorized in 1895. Time was, of course, too brief to make new complete surveys and estimates before the adjournment of the legislature, and therefore use was made of the estimates made near the close of State Engineer Adams' term of office, by the engineers then in charge of the work of construction. To these figures additions have been made for the advance in the price of the materials for the added cost of labor due to the 8-hour law, and for the deterioration that has taken place in the canal during the years since the above estimates were made. On this basis it is estimated that the total present cost of completing the "nine million dollar improvement" on the Erie, Oswego and Champlain Canals will be $19,797,828; and as the State Engineer well says, when this amount of money has been expended the state will have on its hands "an old canal, repaired," whereas the estimates for the barge canal work are for "a modern canal built according to the latest practice and of the highest standard known to modern engineering."

WATER SUPPLY PLANT AT THE NEW KENSINGTON WORKS OF THE PITTSBURG REDUCTION CO.

By Edwin S. Fickes, Jun. Am. Soc. C. E.*

The New Kensington plant of the Pittsburg Reduction Co. is located on the left bank of the Allegheny River, 17 miles above Pittsburg. The water used by the plant has heretofore been supplied by the local water company; but as it has no reservoir reserve excepting a small tank and not infrequently permits the pressure to run very low, the insurance companies required the Pittsburg Reduction Co. to install an underwriter fire-pump, with a capacity of 1,000 gallons per minute, in order to afford adequate fire protection.

Being thus obliged to build a pumping station, it was considered advisable to make it large

*Engineer, the Pittsburg Reduction Co., Pittsburg, Pa.

enough to provide for the future requirements of the works, should the local company at any time fail to give satisfactory service. Space was, therefore, left in the pump well for a triplex pump of 500 gallons per minute capacity, together with the necessary suction connections. This pump when placed, will discharge into an elevated tank, from which water at low pressure will be taken into the water lines leading to different parts of the works. A check-valve between the distributing lines and the tank will enable the fire pump to raise the pressure in these lines to 100 lbs. per sq. in., when it is required, as in case of fire.

The fire pump is the standard type of direct, steam-driven pump, built in accordance with the specifications of the Factory Mutual Fire Insurance Co. The triplex pump, while not yet selected, will, however, be driven by an electric motor, placed on beams above it in the pump-well; the motor being so placed in order to decrease the danger of submergence should a pipe burst or other accident occur, and partly flood the well.

As the difference between high and low water in the Allegheny River at this point is a little over 30 ft., and during winter freshets great quantities of ice and drift are carried by the water, the form of construction shown by the illustration was adopted. The well was set far enough back from the bank to escape damage from ice and drift, and at the same time it was carried down to solid ground so as to afford a good foundation. The well is built throughout of hard burned shale brick, laid in Portland cement mortar.

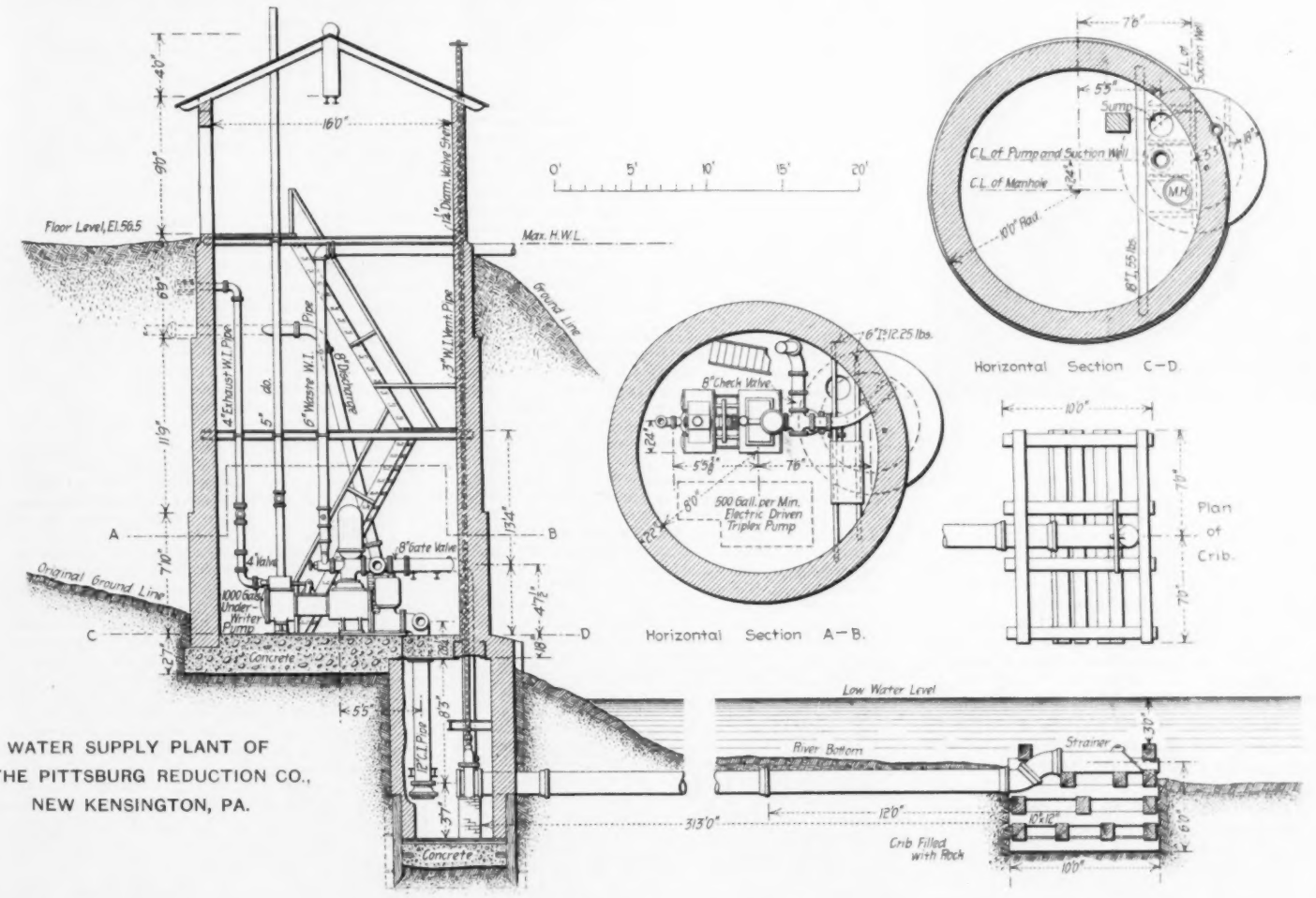
The excavation in the filled ground for the well was made in about three hours by using a 1⅛-in. fire stream at 100-lbs. pressure to wash it out. Work on the intake was next started, when the river was very low, by making the excavation for the crib and pipe line. The hole for the crib and the adjacent pipe line was excavated by a sand dredge; and the rest of the trench, after being surrounded by a cofferdam of river gravel and mud, was pumped out and dug in the usual way. The crib was then floated to position and, as the pipe were laid and jointed, it was filled with rock and sunk to place. The rock was filled in both ends of the crib and around it to the level of the top of the strainer, in order to protect the latter from the sand dredges which frequent this part of the river. The strainer is of cast-iron, with a hinged gate over the end to facilitate the flushing of the intake line.

The intake line is of 16-in. cast-iron pipe, with a gate on the end in the suction well, so that the well can be pumped out and cleaned. An 8-in. by-pass is provided from the fire pump to flush the intake.

Considerable difficulty was experienced in sinking the suction well, which is located in a bed of coarse sand and gravel. As the trouble was anticipated by the writer, the well was started 2 ft. larger in diameter than the finished walls, using 1½-in. hemlock sheet piles, held in place by rings built up of planks sawed to form a circle.

In this way the first 10 ft. were sunk. At that depth, the rush of ground water and sand allowed the gravel to jam the cribbing so that it could be driven no further. In the meantime, a cylinder of 6 × 6-in. × 6½-ft. timbers was built, the staves being beveled on the sides to fit and sharpened at the bottom so as to drive. This cylinder was hooped rather loosely with three ¾-in. round iron hoops and lowered to the bottom of the hole. By driving the staves one at a time, the cutting edge was kept about 15 ins. in advance of the excavation until the desired depth was reached. At the bottom a rough measurement of the discharge of the siphon which was used to pump out the excavation showed a flow of about 8,000 gallons per hour. This water is extremely hard and unfit for use in boilers, so that the well had to be made practically water-tight to keep it out. To accomplish this, the bottom was covered with canvas, which was nailed to the crib all around and about 20 ins. of concrete was rapidly placed and leveled up. The water was then allowed to rise and remain until the concrete was hard. The well was then pumped out and, excepting a few spots, the concrete was found to be in good condition. At the point where most of the water was rising through it, the stone was removed (the mortar having been all washed away), a hole was cut in the canvas, and a sump about a foot in diameter was clawed out in the gravel below. The suction branch of the siphon was inserted in this hole and the water lowered to the bottom of the concrete and held at this point for several days. The concrete was now repaired where it had been washed out and a double floor of 1½-in. tongued and grooved pine was laid. A hole was bored in this floor into which a 6-ft. length of gas pipe was inserted and grout was poured in until it appeared all around the edges of the floor. The brickwork was then started and carried up to above the ground water level. The elbow joining the siphon to the pipe passing through the floor was then broken, and after waiting a few weeks to allow the cement to harden, the pipe was capped; and with the exception of several small leaks in the brickwork, the well was found to be water-tight.

After the brickwork was above the ground water level, no further difficulty was experienced, and the works (Dec. 13, 1900) are rapidly approaching completion.



WATER SUPPLY PLANT OF THE PITTSBURG REDUCTION CO., NEW KENSINGTON, PA.

A PRECARIOUS TRANSIT STATION.

The illustration on the following page is reproduced from a report upon the survey of the boundary between Idaho and Montana, made by Mr. Richard U. Goode, and published as Bulletin No. 170 of the U. S. Geological Survey.

As is very evident, the engineers were compelled to utilize some rather ticklish points as transit stations in running the stadia random lines. And under such conditions, it is somewhat remarkable that in a comparison between steel tape and stadia measurements, made on this survey, the error was found to be only 1 in 286; or a difference of 116 ft. in a distance of 33,219 ft.

The important monuments used to mark this boundary were solid granite posts, 10 ins. square and 6 ft. long; undressed, except for a space sufficient to permit the cutting of the words "Idaho"

and "Montana" on opposite sides. As it was impossible to transport the whole post to some of the points to be thus marked; for such places the post was cut into ten pieces, transported to the boundary on the backs of mules, and then bolted and cemented together. For other monuments, hollow wrought-iron posts were employed, 6 ft. long and 4 ins. outside diameter, and thoroughly cov-

A Transit Station on the Idaho-Montana Boundary Survey.

ered with a coat of asphaltum tar. These iron posts were flared at the bottom to a width of 12 ins., were buried 3 ft. in the ground, and then surrounded by a conical mound of earth to a height of 2 ft. On the top of each post was riveted a bronze cap with appropriate lettering and marks showing the direction of the boundary line.

These monuments, where practicable, were witnessed by pits and mounds and by blazed trees; and under each monument was placed about a quart of charcoal.

REPORTS PRESENTED AT THE ANNUAL MEETING OF THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION.

In our issue of March 14 we gave abstracts of some of the reports presented at the annual meeting in Chicago, and now give below abstracts of other reports. Notes of the discussions and general proceedings will be found in another column:

MASONRY.

STONE MASONRY.—Some railways using sandstone for stone masonry use limestone for concrete masonry, but give no reason for the exclusion of sandstone from the concrete. Stone has in the past been pre-eminent in railway work, but the conditions are now modified by the successful and cheap manufacture of vitrified brick and Portland cement, permitting their extended adoption in permanent structures in localities where the absence of suitable stone makes its cost excessive and prohibitory.

The present time finds each railroad supplied with a knowledge of the variety and quality of stone at its disposal, and its choice is limited by economic reasons. The primary requisite is cheapness, and a comparative estimate with other available material quickly decides whether it may or may not be used.

Durability is the second requisite. Selection is made from material having a good record, and laboratory tests are seldom necessary for ascertaining merits or defects. Composition, texture, hardness, strength and structure are attributes of durability. Appearance, as far as the generality of railroad structures is concerned, is of minor importance.

The essential qualities of a good building stone may, in a general way, be said to be a homogeneous and compact texture, a grain not too coarse and constituents or cementing material not readily soluble. It should show a clean fracture and give a clear ringing sound when struck, and, finally, in order that it may not be too expensive, it should be capable of being easily worked.

BRICK MASONRY.—This appears to be used but sparingly, principally probably, in end walls to pipe culverts,

TABLE II.—Principal Wood-Treating Plants in the United States.

Location.	Year when built.	Owner.	Process.	Kind of wood.	No. of retorts.	Estimated capacities per annum.
Lowell, Mass.....	1848.	Locks & Canal Co.....	Kyanizing	Various.....	2	30,000
LasVegas,N.Mex..	1885.	Atch., Top. & Santa Fe Ry.....	Zinc-tannin	Pine, etc.....	3	500,000
Bellemont, Ariz...	1898.	Atch., Top. & Santa Fe Ry.....	"	Pine, etc.....	2	350,000
Chicago, Ill.....	1886.	C. Tie Preserving Co.	"	Hemlock.....	4	500,000
Mt. Vernon, Ill...	1899.	C. Tie Preserving Co.	"	Black oak.....	1	200,000
Houston, Tex.....	1891.	Southern Pacific Co.	Burnettizing	Pine,Fir,Spruce,&c.	5	1,500,000
California.....	1894.	" " "	Burnettizing	" "	2	1,000,000
Oakland, Cal.....	1889.	" " "	Creosoting	" "	2	1,000,000
Edgemont, S.Dak.	1899.	Chic., Bur. & Quincy R. R.....	Burnettizing	Pine, etc.....	2	500,000
Somerville, Tex...	1897.	T. Tie & Lumber Co.....	Zinc-tannin	"	6	2,000,000
Beaumont, Tex....	1897.	International Creoso. & C. Co...	Various	"	1	500,000
Perth Amboy, N.J.	1890.	Barschall Co.	Hasselmann	"	3	1,000,000
Perth Amboy, N.J.	1895.	U. S. Wood Preserving.....	Creosote resinate.	"	4	1,200,000
Brooklyn, N.Y.....	1878.	Eppinger & Russell.....	Creosoting	"	4	800,000
Norfolk, Va.....	1896.	N. Creosoting.	"	"	4	900,000
W. Pascagoula....	1876.	Louisville & Nashville R. R....	"	"	2	400,000

city abutments, arch rings and tunnel linings. The principal requisite in a good brick is thorough burning, even to the point of vitrification, but too much vitrification has a tendency to reduce the adhesion between the brick and the mortar, but with more complete experimental data, the degree of vitrification allowable may be indicated by the absorptive power of the brick, making a simple and effective method of testing the quality.

CONCRETE.—We come now to the consideration of a class of masonry, the usefulness and adaptability of which to the purposes of the constructor are becoming more fully appreciated continually; its application is almost universal, enabling permanent structures to be built where, for the lack of suitable material, stone masonry is impracticable.

A comparison of the reports indicates a tendency to increase the strength of the matrix and reduce its volume by the addition of gravel and the use of unscreened stone to assist in filling the voids in the material mass; the stated proportions varying from 1, 2 and 4 to 1, 3 and 6, with gravel added in most cases, but volume not stated; a few report the use of gravel alone without the use of broken stone.

Limestone and sandstone are most generally used, probably on account of the cheapness of crushing, but several lines exclude the use of sandstone from concrete masonry, although using it principally or exclusively for stone masonry; no reason is assigned for this, and it may be due to local conditions entirely and not to any unsuitable characteristics of sandstone for the purpose.

The largest size to which stone is allowed to be crushed is 2½ ins. with the preponderance strongly in favor of 2 ins. No information has been received relative to the use of "one-man" stone, or rubble blocks in the mass of pier masonry, as an element of economy, but such use is quite usual, and we believe it to be permissible under proper restrictions and supervision.

With respect to the relative values of Portland and natural cement, the preponderance of opinion is that Portland should be used for all important structures exposed to the weather, and that the use of natural cement should be confined to interior work and dry foundations. The use of the two cements adjoining in the same work is of questionable propriety, but in the absence of actual information we are not prepared to condemn it at present.

The expansion and contraction of large masses of concrete, with resulting cracks in the final setting, introduces a factor requiring careful attention in the construction of long walls and large piers, but this being a matter of design, it will be treated in the division upon that subject.

The resistance to the action of frost and to the impact of ice and drift appears not to be so serious as has formerly been supposed; examples of excellent and durable work in our colder climates are not wanting, and work put up in zero weather affords ample indication that with proper care and precaution concrete masonry can be constructed at a season of the year when it would be unwise to attempt stone or brick masonry. We would especially emphasize the necessity of heating the stone as well as the sand before mixing in very cold temperatures.

The advantages of concrete masonry cover a wide field; the cost of transportation of the constituent material is lower than the mass of other classes of masonry; it is economically handled at the site of the work, and there is no waste material unsuitable for use at other points. Skilled labor is not a requisite, and much of the ordinary labor may be substituted by machine mixing where the volume of the work will warrant. It is, perhaps, the cheapest and most satisfactory method of repairs and enlargement of old structures, and for increasing the strength of arches is of the utmost value. It is of interest to note that in the eastern and middle states, where first-class masonry stone is universally obtainable, that the concrete form is gradually taking its place, almost as universally as in the Mississippi Valley states, where quarries suitable for stone masonry are rare.

A comparison should be made between the cost of a permanent structure and the capital to be invested to provide for the construction and maintenance forever of a temporary structure. To ascertain this we must consider a sum which is made up of the initial cost of the temporary structure, to be expended at the present time, plus an amount which at current rates of interest compounded will at certain recurring intervals of years, representing the life of the temporary structure, provide an amount necessary to rebuild it whenever it may be worn out.

Let

S = The above sum.
I = Initial cost of temporary structure.
P = An amount which at intervals of "n" years (the life of the structure) at current rates of interest compounded will produce I.
r = Current rate of interest.
n = Life of temporary structure.
$(1 + r)^n$ = expression for compound interest.

Then

$$S = I + P$$
$$P \times [(1 + r)^n - 1] = I. \quad (1)$$

$$P = \frac{I}{(1 + r)^n - 1}. \quad (2)$$

Substituting

$$S = I + \frac{I}{(1 + r)^n - 1}.$$

$$S = I \times \frac{(1 + r)^n}{(1 + r)^n - 1}.$$

For example, what amount may be expended at the present time to replace a wooden trestle 100 ft. long, costing $1,000, and having a life of 10 years, rate of interest 5%? $(1 + r)^n$ being the expression for compound interest, $1 at 5% for 10 years amounts to $1.63. Substituting in equations (3), we have

$$S = 1{,}000 \times \frac{1.63}{0.63} = 2{,}590 = I + P.$$

$$P = 1{,}590.$$

Therefore, $2,590 is the amount which is practically set aside for the construction and maintenance forever of this trestle in wood. One thousand dollars of this amount is taken to rebuild it at the present time, and the remainder $1,590 is placed at interest to again accumulate $2,590 at the end of 10 years. An expenditure of at least $2,590 is therefore justifiable for permanent improvements. If this trestle is replaced by a culvert and earth filling, the saving from annual maintenance of the temporary structure should also be considered. If this amounts to 25 cts. per ft., or in this example $25 per year, the capitalized amount is $525 to be added to $2,590. If replaced by an iron span, the maintenance saving is less. If 5% interest is considered excessive, a reduced rate may be used, which increases the capitalized amount: In this example, at 4%, $3,088 is a justifiable expenditure; at 3½%, $3,440.

It is to be observed that an expenditure of $1,000 for a structure to last 10 years is not represented by a rate of $100 per year, as is often stated. $100 capitalized at 5% is $2,000, to which if added $1,000 (the present expenditure) makes $3,000, instead of $2,590, as above determined. $1,590 and not $2,000 is the amount from which the annual rate is ascertained, and in this case is $79.50, not $100. For proper determination of these values it is always necessary to apply compound interest.

W. L. Breckinridge, C., B. & Q.; E. P. Dawley, N. Y., N. H. & H.; William Hood, So. Pac.; H. G. Kelley, Minn. & St. L.; W. E. Hoyt, Con. Engr.; F. S. Stevens, Phil. & Read.; C. F. W. Felt, G., C. & S. F.; B. T. Fendall; F. M. Bisbee; C. E. Lindsay, So. Ry.

TIES.

Up to the present time, each railway company has found it best and most economical to use ties made from those timbers which are nearest to its territory and therefore the most available and economical. The value of these woods is consequently pretty well known to the adjacent railroad companies at the present time. For instance, it is well known to the companies operating in the eastern, middle and some of the western states that a life of 8 and 9 years is obtained in main tracks for white oak ties, and that they are the best ties which they can obtain. The Canadian roads are restricted to the use of cedar and hemlock for the most part, the southern roads to yellow pine and the western roads to mountain pine and redwood.

The eastern and middle states roads now find that they are compelled to go farther each year to secure the valuable white oak ties and that at the same time, the price is steadily increasing, indicating a growing scarcity of the supply. They will therefore make inroads on the timbers considered less valuable for ties, such as yellow pine, hemlock, cedar, tamarack, mountain pine and redwood, which additional consumption reduces the available supply for roads now using these timbers, and hence the tie question is becoming of importance to all the consumers.

The subject of metal ties has received so little attention in this country, and the cost as compared with wooden

ties is so great, that this does not appear at present to be a live question.

PRESERVATION.—Ties of durable woods have hitherto been so abundant and cheap in the United States, that there has been little inducement to prolong their life by chemical preparation, a practice now uniformly prevailing in Europe. This fortunate American condition is passing away, and already some 3 or 4% of the 100,000,000 ties annually laid or renewed in this country are being chemically injected. This treatment is applied to the inferior woods which are still copious, and the practice will grow rapidly, as the economy is one of fast increasing importance.

EXTERNAL APPLICATIONS.—There are a number of compositions which are being promoted, to be applied by painting or by soaking. They are chiefly used for framed timber and joints, but are also recommended for ties. It is recognized as essential to success that the wood should be well seasoned, so that the moisture and germs shall not be incased (a condition well known to produce quick decay), but that the composition shall soak in. When this is well done, good results have been reported for ties so treated, but it is probable that the success is due either to favorable exposures, or to the application of large quantities of the composition. Diligent enquiries have quite failed in procuring data as to the quantities absorbed by the ties whose long life is reported, and the amounts now recommended by the manufacturers of the products appear to be estimates. The following table condenses the claims made for the principal external applications now in the market:

Name.	Price per gallon cts.	Per tie—Quantity used gall.	Per tie—Cost, cts.	Life, years.
Carbolineum avenarius.*	80	¼	15 to 20	7 to 18
Ligni salvor.†	..	¼	....	....
Woodiline.‡	25	½	15 to 18	6 to 14
Spirittine.	25	½	12½	7 " 18
Wood preservative.‡	..	..	....	....

Composition: *Tar oil, chlorine, etc.; †Tar oil, etc.; ‡Both this and spirittine are a chemical compound; ‡Distilled from pine, used by Pennsylvania R. R. for car work.

INJECTION OF CHEMICALS.—A good many different chemicals have been experimented with for preserving ties. Of these, corrosive sublimate, sulphate of copper, chloride of zinc and creosote have proved their superiority over others, but the first two are now practically abandoned and only the latter two remain in extensive use.

Various modes of injection have been tested, such as soaking, boiling, vital suction, endwise application (Boucherie process) and pressure in closed retorts. Only the last mode now survives and this has been adopted by all the pioneer American railroads above alluded to.

The process generally consists in loading the ties upon special buggies, running these into a retort or cylinder some 6 ft. in diameter and 100 to 115 ft. long, closing this air tight, and then subjecting the ties to the following operations:

1 Steaming at 20 lbs. pressure .....2 to 5 hours
2 Vacuum from 18 to 26 ins. mercury .....1 to 2 "
3 Antiseptic solution, with 110 lbs. pressure..2 to 5 "
4 Subsequent solution, if any .....1 to 2 "
5 Opening retort and recharging .....1 to ½ "

The whole process occupies from 6 to 12 hours as applied at different works. The quantities absorbed are ascertained by gaging the tanks holding the solutions, and the actual weighing of the ties in and out is found at one plant to be an important check. The time occupied by treatment in Europe is about one-half of the above, in consequence of better prior seasoning of the ties.

Table II. exhibits the particulars of various plants. The estimated capacities are as stated by the parties and are given in ties which can be treated in a year, although the creosoting plants practically do none of this class of injection, but operate on piles and timber, upon which they do good work.

Creosoting is the standard mode of tie preservation in Europe. It is much the best, but is expensive. It costs there from 25 to 65 cts. a tie, in accordance with the quantities injected, and would cost still more in this country, giving a life of 15 to 27 years in the track. American roads can hardly afford to apply this process to ties, costing, untreated, about one-third as much as the European ties, but may be content with inferior processes. These are chiefly "Burnettizing" and "zinc-tannin," giving a life of 10 to 15 years, but there may be advantage in the "zinc-creosote" process, worked in Germany since 1874, which there costs 19.2 to 20.4 cts. each for first-class ties, and is said to give them a life of 12 to 18 years.

It is to be expected that, having made much the same class of mistakes as the Europeans did in the beginning, i. e., imperfect work for lack of knowledge, we shall now gradually improve our practice and obtain better results than we have done. There is nevertheless a marked economy obtained by the pioneer roads. Let us take the Southern Pacific as an example. The untreated pine ties cost about 50 cts. each when laid in the track in their natural state, and last some 4 years; this produces a charge of 12½ cts. a year per tie, while if, when treated, they cost, say, 66 cts. each when laid in the track, and last at least 8.25 years, they then produce an annual charge of 8 cts. per tie. The economy will vary on different roads; on some there will be none at all. Some railways are able to obtain white oak ties costing 48 cts. each in the track and lasting 8 years, or 6 cents a year per tie; others obtain cedar, cypress, or redwood, to cost, say, 66 cents each when laid, and lasting 11 years, thus again producing an annual charge of 6 cts. a tie, but on many roads the durable woods are so far exhausted that they must resort to the inferior woods and treat them chemically to prolong their life. Each railway must consider the problem for itself, and the present report can only state general facts.

The annual tie renewals vary greatly on different lines; data recently compiled by the "Texas Association of Superintendents of Railways" shows that the ties replaced on an average for 9 years in that state run all the way from 160 a year per mile for cypress, thus indicating a life of 16 years on a line 6.7 miles long, to 555 a year a mile for oak, or a life of about 5 years, on a line 192 miles long. The latter road pays 25 cts. apiece at the distributing points, the ties thus costing about 45 cts. each in the track, and it could probably afford to have them treated if it were assured as to the best process to use under its circumstances. We may now expect, during the next few years, to have a number of new processes brought forward, but it will take a long time to determine their efficiency.

Since receiving the above the committee has received the results up to date, of an interesting experiment in west Texas on a piece of new line built by the Southern Pacific Co., in September, 1895. It is well known that the action of chloride of zinc is to shorten the grain of timber, and many yellow pine ties treated with this preservative are removed from the track on account of shattering or separation of fibers long before decay sets in. This trouble forced itself on the attention of the officers, and it was decided to lay an experimental lot of yellow pine ties, impregnated with so small a quantity of creosote oil as to make the total cost of treatment reasonably small.

Accordingly, 1,694 sap pine ties, cut at east Texas mills, were impregnated with 0.68 gallon of creosote per cu. ft., or 1.8 gallons per tie, at a total cost of treatment of about 19 cts. per tie at the works. At the same time, about the same number of untreated pine ties of the same character were laid alongside the creosoted ones. At the beginning of this year, or after five years' and four months' service, not a single one of the creosoted ties had been removed from the track, whilst 292 of the common pine ties, or 16% of the total number put in, had been taken out on account of decay.

If the thorough sterilization of the timber in the retorts and the subsequent injection of so small a quantity of oil, which amounts to but little more than what might be termed a thorough soaking, will add materially to the life of ties at a cost of 19 or 20 cts., and if it will remove the objections of splintering, which, with the variety of pine in question, is one of the greatest objections to burnettizing, as well as the trouble from the extreme solubility of the zinc salt, the experiment would seem to offer considerable promise of a solution of a serious problem.

INSPECTION.—The inspector must be given no latitude as to the interpretation of the specifications, which should be so explicit as to leave no opening for a misunderstanding. In case of injustice on the part of the inspector, appeal should always be had to his superiors, and an adjustment made. Each tie must be turned over and examined by the inspector and so marked on the end that the mark cannot be changed or obliterated by the weather. Inspection after removal for condemnation or re-use is most important and should be done by competent authority. The ties should be piled after removal in a neat and orderly manner for convenient inspection by the proper officer.

The employment of preserved ties is now increasing, and it should be the work of this committee to keep track of what is being done. In order that accurate information concerning the life of ties may be kept, each tie may be marked with a copper or galvanized iron nail, with the date, in two figures, stamped on the head. On one road cast-iron dating hammers are used. These have the date cast on one face in raised numbers, and the ties are stamped on the "lined-up" ends by striking them a smart blow with a hammer. When any ties so marked are removed from the track they should be reported through the regular channels to the division engineer.

A uniform set of specifications for present use would be a benefit both to the railroad companies and to the tie-makers. As it is now, where different railway companies purchase ties in the same territory, it is customary for several inspectors to go over the same lot of ties, each picking out ties which come nearest to his specifications, which leads to a great variety of classes of ties and creates trouble for all concerned.

Tie-plates have now become a well-established article of manufacture. Those principally in use consist of flat-rolled steel, with ribs and surfaces of various forms. Their utility for saving soft ties is so well established that it seems superfluous to report in favor of their use. In setting tie-plates, they should be set squarely upon the ties and be firmly imbedded in them, so as to place the bottom of the tie-plates exactly flush with the tops of the ties. They should not be left partly driven, with a view of having them forced down by the weight of a train. Where tie-plates are punched for more than one section of rail, care should be taken to place the plates on the ties with the gage side of plate corresponding with the gage side of rail. This is important for the reason that unless it is followed heavy rail cannot be laid to replace lighter sections without removing the tie-plates. For the convenience of sectionmen the shape of the hole punched on the side next to the flange of rail and on the gage side of plate should be indicative of the weight of the rail to be used.

J. Kruttschnitt, So. Pac.; Geo. W. Kittredge, C., C., C. & St. L.; O. Chanute; J. J. Frey, F. & C. C.; J. C. Nelson, N. Y. C.; W. L. Darling, Nor. Pac.; Wm. Archer, B. & O. S. W.; W. C. Cushing, Pa. Lines; Lewis Kingman, Mex. Cen.

RAILS.

It would appear from the present practice and the future outlook that there are more sections provided than are necessary. Consideration of figures furnished would indicate that five different weights of rail ought to cover the general requirements of all railways, as follows: 60, 70, 80, 90 and 100 lbs. Seven roads have axle loads from 20,000 to 25,000 lbs.; 11 roads, 25,000 to 30,000 lbs.; 23 roads, 30,000 to 35,000 lbs.; 23 roads, 35,000 to 40,000 lbs.; 38 roads, 40,000 to 45,000 lbs.; 14 roads, 45,000 to 50,000 lbs.; four, 50,000 to 55,000 lbs., and none over 55,000 lbs. These figures indicate that very few roads will require light rail, and a very large number of roads will require 80 or 90-lb. rails. The Am. Soc. C. E. sections are giving general satisfaction. There are a number of roads not using the sections, stating that they have no particular objection to them, but do not wish to change on account of having so much rail of other sections. Other roads report that their sections are so close that they do not think it worth while to change.

In the recent development in rolling rails at a lower temperature, some difficulties have been developed with the Am. Soc. C. E. sections on account of this change of finishing temperature of rails which indicates that the flange will probably have to be increased. This matter has been developed so recently that we are not prepared to submit new sections.

About 90% of the railway mileage is either straight track or with curves less than 2°, leaving less than 10% of the track where there might be extra flange wear on account of curves. We therefore do not consider it necessary to do any work in the way of suggesting special sections for the special conditions that might arise on 10% of our track, but it should be our aim to conform our standards to what will suit the other 90%.

The minimum standard length of rails should be 33 ft. and 5% of the order should be accepted in shorter lengths, the minimum length being 27½ ft. The 33-ft. length should not cost any more per ton than 30-ft. rails, and it has the great advantage of reducing the number of joints in the track 10%. A number of roads have made 33 ft. the standard length, and the mileage represented by the roads having the standard length is about 14,000 miles, about 10% of the mileage represented in the association.

We submit a table showing the proper allowance to make for expansion for 33-ft. rails. The temperature shall be taken on the rail, and the openings between the rails shall be as follows:

Temperature.	Amount of opening.	Temperature.	Amount of opening.
20° to 0° F.	5/16-in.	50° to 75° F.	⅛-in.
0° " 25? F.	¼-in.	75° " 100° F.	1/16-in.
25° " 50° F.	3/16-in.		

Over 100° rail to be laid close without bumping.

R. Trimble, S. M. Felton, A. W. Johnston, Thos. Purcell, W. T. Manning, C. E. Wickham, R. W. Hunt, J. H. Wallace, G. B. Woodworth, W. R. Webster.

DISCUSSION.—The report was accompanied by the proposed rail specifications prepared by the American Section of the International Association for Testing Materials. In the discussion, Mr. Prout (Railroad Gazette) remarked that the heavier rails of the Am. Soc. C. E. section are not giving as good wear as had been expected. Mr. Trimble (Pennsylvania Lines) said that 70% of the rails made last year were of these sections, and that trouble in rolling had only developed with the new process of finishing at a low temperature. Mr. E. E. R. Tratman (Engineering News) thought that before any new sections are adopted the co-operation of the American Society of Civil Engineers should be sought, so as to avoid possible confusion due to having the old Am. Soc. C. E. sections and the new M. of Way Assoc. sections both in use. As the number of forms of section have now been reduced to a minimum, he thought it would be very desirable to reduce the number of weights of sections, as proposed by the committee.

As to length of rails, Mr. Carrothers (B. & O. S. W. R. R.) is using 33 ft., with 60 ft. at road crossings to avoid joints in the crossing. Mr. C. C. Churchill (N. & W. R. R.) has laid 65 miles of 60-ft. rail; there was no serious extra cost in transporting, laying or maintaining, and they have given very long wear under very heavy traffic. They cost more in the first place, partly because it has been found impracticable to camber them so that they will be straight, and they therefore require a good deal more work in the straightening press. Mr. Trimble (Pennsylvania Lines) remarked that railways were only now beginning to realize the importance of keeping accurate record of traffic tonnage and rail wear.

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As briefly noted in our last issue, the New York Chamber of Commerce has set itself at the task of solving the Brooklyn Bridge terminal problem.

Many of our readers will recall that this same problem was a subject of lively discussion fully a dozen years ago, and has been revived at intervals of a year or two ever since. It is a familiar fact, also, that the various solutions which have been attempted have proved to be inadequate to meet the conditions for more than a short period. It is probably true likewise that at no time in the past have the inadequacies of the solutions thus far tried been more glaringly evident than they are at present. In calling attention to the unsupportable congestion and confusion of traffic at the New York terminal of the bridge, therefore, the Chamber of Commerce has presented no information not already well known to every intelligent observer of the conditions; it has, however, performed a meritorious service in setting about a search for a remedy to these conditions, and for this reason deserves hearty praise. It is hardly necessary to say that engineers who have studied the problem will await with unusual interest the report of the Special Committee of the Chamber of Commerce, containing its suggestions and plans for improvement. If the interviews published in the daily papers are to be depended upon, this is practically the attitude toward the Chamber of Commerce movement, which is taken by the engineers of the bridge and of the railway companies who use it for their cars. The city Commissioner of Bridges frankly states that his engineers have done all that they can do, and that he awaits with interest the results of this or any other serious attempt to solve the problem by other engineers. President Rossiter, of the Brooklyn Rapid Transit Co., which operates the surface and elevated railway lines whose cars cross the bridge, has somewhat more definite ideas as to the solution of the problem, and states unhesitatingly that, in his opinion, the only thing that will help the situation materially is the remodeling of the bridge terminals so that loops can be built for the elevated trains; with a loop at each end, he states, "six-car trains could be run around close to each other." The older readers of Engineering News will remember that the loop terminal plan was suggested by this journal as far back as 1887 as the one fundamentally best in principle to meet the traffic conditions at that time, and to expand with the future growth of traffic. Many of the arguments then made to substantiate this assertion are just as true to-day, but the problem has attained entirely different proportions. Whether the construction of loop terminals for the elevated railway trains, as suggested by President Rossiter, would be of more than temporary benefit, unless the terminal space should be materially enlarged, is at least a debatable question. The fundamental difficulty of the terminal problem at the New York end of the Brooklyn Bridge lies in the fact that the space available for terminals is at present too restricted, first, to allow for an arrangement of tracks which will give the most freedom to train movements, and, second, to permit the separation of the different currents of traffic so that they will not conflict. With adequate terminal space the terminal problem is one which is comparatively easy of solution within obvious limits; but with the present restricted terminal space, it is one which will tax the ability of any one to solve in a satisfactory manner.

The outlook for an enlarged water supply for Greater New York is much brighter, now that the legislature has finally repealed the act of 1895, which conferred extraordinary powers on the Ramapo Water Co. This new legislation, coupled with an earlier act, which gives the city itself the power to condemn needed sources of water supply, makes it possible for the city to supply its own needs, and relieves it from dependence on a private corporation, possessing the power to control water supplies which the city itself could not touch. It is true the Ramapo Water Co., which, in 1899, came so near securing a $200,000,000 contract for the supply of water to New York, still exists; but it has now no greater powers and privileges than any other private water company.

It is to be hoped that the city officials will now take immediate steps to guard New York from the danger of a water famine. The questions involved are the curtailing of waste and the provision of a new supply. As a pure business proposition, the first, alone, might solve the problem, at least for the borough of Manhattan, but unless intelligent citizens, generally, grasp the situation and demand waste restriction, nothing short of a huge additional supply will avail. As matters now stand, investigations and plans for a new supply should be put under way at once, and at the same time systematic measures to curtail waste should be undertaken.

The second annual meeting of the American Railway Engineering and Maintenance-of-Way Association, which was held in Chicago last week, was looked forward to with some curiosity and perhaps a little anxiety, by many of its members. There were not a few predictions that the enthusiasm and energy displayed at the first meeting would not be sustained. The results of this meeting, however, were very encouraging to those who look for a successful future for the new association. Already the society numbers 359 members, representing some 140 different railways, with a total mileage of approximately 175,000 miles.

There were, it is true, some unsatisfactory features in the proceedings, but no more than might naturally be expected from a new organization which has still to gain experience in its field of work. One notable feature was the varying character of the organization and work of the several committees. Some of these committees worked together as a whole, and submitted reports which represented the views and opinions of all the members of the committee, as arrived at by careful discussion of the subjects under consideration. Others divided up their work among sub-committees, and then either compiled a general report from the reports of sub-committees, or simply submitted the set of reports, which of course represented mainly the views of the few members of each sub-committee. Other committees delegated certain sections of their work to individual members, so that the report was not properly a committee report at all, but simply a set of individual papers. This latter plan was criticised sharply criticised. No fault was found with the individual papers as such, but it was generally felt that the committees should present something more conclusive than the results of individual investigation.

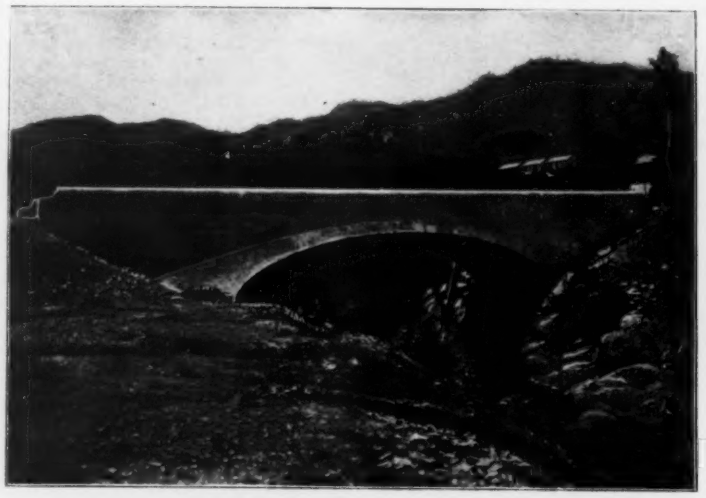
Several of the committees endeavored to cover too wide a field, and presented a mass of undigested information covering matters of detail or of individual practice on different roads. It would have been much better if one or two subjects had been selected and thoroughly investigated. As all the committees are standing or permanent committees, to cover the entire field—if that were possible—would leave nothing for the committees to do in the following year. It was evident from some of the remarks made that this feature of the Association's work was not definitely understood, some of the members of the committees considering their work to be concluded with the presentation of their reports at this year's meeting.

Notwithstanding the above criticism, the new association deserves congratulations on the fact that out of 14 committees, only one failed to make a report, while printed copies of the 13 reports were distributed at or before the meeting. This certainly indicates that the members of the committees are willing to work, and that defects in the character of the work are largely due to the fact that the members of the committees were not fully informed as to what was expected of them and what methods to pursue. With these facts before it, the Board of Direction intends in future to take the part of a general supervisory committee, advising and instructing the chairmen of the several committees as to the work to be done and the best methods for carrying it on.

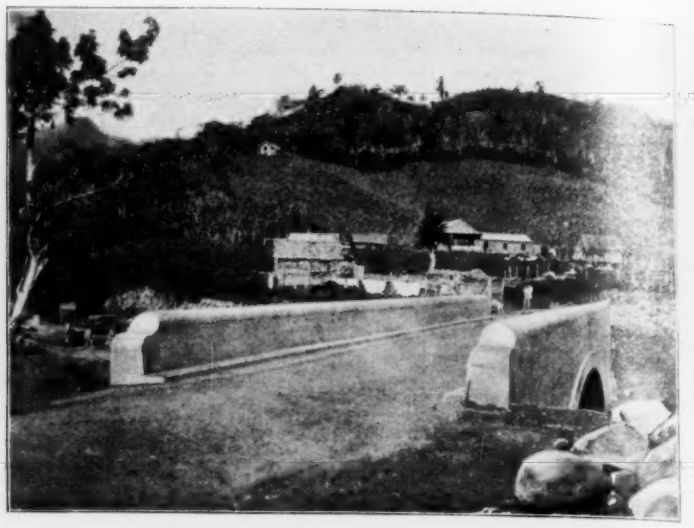
A good suggestion for increasing the usefulness of the association was that the information gathered by a committee during the year should in some way be made available before the date of the annual meeting, especially as much of the detail information does not appear in the committee reports. Thus members desiring information on any particular subject might make application to the Secretary, who would forward to the chairmen of the proper committee, who might then furnish such information as they felt could properly be given. The Board of Direction would perhaps exercise some supervision over this distribution of special information. In line with this suggestion it may be noted that the committee on signaling and interlocking has prepared plans for certain standards, and suggested in its report that the tracings should be kept on file at the secretary's office, where blue print copies could be obtained by members desiring them.

WHAT WILL THE STATE OF NEW YORK DO WITH ITS CANALS?

As our readers are aware, the question, What shall be done with the Erie Canal? is one which has perplexed the people of New York for more than a half-dozen years. In 1895, the people of the State voted in favor of the issuance of State bonds to the amount of $9,000,000, on the understanding that this expenditure would deepen the canal to 9 ft. When this money had been spent, it was found that the deepening was not half completed; and that for practical purposes the canals were in little, if any, better condition than before the work was begun. In 1899, Governor Roosevelt appointed a commission, headed by Gen. Francis V. Greene, to investigate the whole question and report as to what policy the State should pursue toward its canals. The report of that commission (abstracted in our issue of Feb. 1, 1900), favored the radical enlargement of the Erie Canal to accommodate barges of 1,000 tons capacity and 10



55-ft. Concrete Arch over Rio Grande at Adjuntas.



Parapets of Adjuntas Concrete Arch.

Heavy Retaining Wall North of Caguanitas Bridge.

Heavy Excavation; Utuado in Background.

Excavated Road in Rio Grande Valley.
ROAD FROM ARECIBO TO PONCE.

Three Loops on Maximum Grade Descending the Summit Toward Adjuntas.
ROAD FROM ARECIBO TO PONCE.

HIGHWAY CONSTRUCTION IN

Capt. W. V. Judson, Corps of Engineers, U. S. A

Earth Excavation. (The Hillocks Carry the Center Stakes till Sub-Grade Work is Completed.)

Typical View of Old Road.

Breaking Stone for First Course.
ROAD FROM MOCA TO SAN SEBASTIAN.

Making Concrete Pipe.
ROAD FROM CAGUAS TO HUMACAO.

A Concrete Culvert with Long Retaining Walls.
ROAD FROM ARECIBO TO PONCE.

Rolling Second Course of Stone.
ROAD FROM GUAYAMA TO ARROYO.

juntas.

TRUCTION IN PORTO RICO.

eers, U. S. A., President, Board of Public Works.

ft. draft, and estimated the total expense of this work at $58,000,000.

Following this report, the New York legislature appropriated $200,000 for the purpose of making complete surveys and estimates for such a large barge canal, as the commission recommended and placed the work under direction of State Engineer Bond. A report of the results of these surveys was made to the Governor by Mr. Bond on Feb. 12; and an abstract of the report appearing in the newspapers in more or less incorrect form, was printed in our issue of Feb. 28. On March 14, the full text of Mr. Bond's report was made public, and it is abstracted at length elsewhere in this issue.

Briefly summarized, the detailed surveys carried out under Mr. Bond's direction by an able corps of engineers, show that a 1,000-ton barge canal from Troy to Buffalo can be built for $50,000,000 to $52,000,000 if it runs via the Mohawk and Oswego rivers and Lake Ontario, $72,000,000 if it follows the Mohawk and Seneca rivers, and $82,000,000 if it follows substantially the present Erie Canal route.

When these figures were presented to Gov. Odell, however, he asked for supplementary estimates of the cost of completing the so-called nine-million-dollar improvement, authorized in 1895. An estimate for this work was, therefore, made by Mr. Bond and his assistants, and amounts to $20,000,000 in round numbers. In presenting this estimate, Mr. Bond pointed out that when this amount has been spent the State will have an old canal repaired, whereas the larger estimates given above are for a new canal throughout, built in a first-class manner, and fitted to perform transportation service on modern lines.

With all these figures, and the detailed reports of the engineers before him, Gov. Odell, on March 15, sent a special message to the legislature in which he recommended the completion of the "nine-million-dollar" work, as, on the whole, the most advantageous to the State, and advised that the people be given an opportunity at the coming election to vote upon the issuance of bonds to the amuont of $20,000,000 for canal improvement.

The reasoning by which the Governor reached this conclusion is interesting, and we print the following extracts from his message:

The question of improving the canal system or abandoning it altogether is thus presented for your consideration. Whether the canals have outlived their usefulness, whether if abandoned increased railroad charges would result, are questions of grave import, and should be carefully weighed and considered so that a conclusion may be reached and the course the state shall pursue with reference to the canal system established.

It is claimed, and the figures no doubt bear out the statement, that the canal, counting merely the costs resultant from expenditures for construction and improvements, disregarding the interest charges, has more than paid for itself. If, however, we add to this cost the interest upon the investment, it is doubtful whether such a conclusion can be drawn.

The average cost of transportation of cereals by railways has been 2.5 mills per ton mile from Buffalo to New York. Under the present Erie Canal the cost per ton mile, according to the Greene report, is 1.75 mills, and under the Seymour plan (the Act of 1895), if the canal were completed according to those plans, the cost would be 1.16 mills, while under the proposed barge canal it would be .88 mills. This, of course, represents only the carrying charges and has nothing to do with the interest on the investment. In making a comparison with the railroad charges it should be added. Taking the most favorable basis, and estimating that the tonnage would exceed 10,000,000 tons, there should be added, if the fourth plan should be adopted, the interest on the ultimate cost, which would be $110,000,000. This at 3% would be $3,300,000. Adding this to the mere cost of transportation of .88 mills per ton mile the result would be .886 mills. Completing the canals under the plan of 1895 the new capital would be $25,143,241, which, at 3% interest and estimating the tonnage at 10,000,000, would be 1.161 mills per ton mile. The only difference in the cost per ton mile between the $25,000,000 plan and the barge canal would be .275 mills per ton mile. We thus see that, from a competitive point of view, the canal can under either of these plans carry freight at a lower rate than the railroads, and the rate by both plans being so much below the lowest rate given by the railroads per ton mile, it would seem that the advantages of the barge canal were not great enough to warrant the increased expenditure.

Directing attention again to the report of the State Engineer, we find that the economical point at which boats can be moved is 3 miles per hour in regular canal prism, 3¼ miles in rivers canalized and 4.4 miles in open water. Mr. Sweet, to whom this question was referred, believes that a higher speed than three miles per hour in the regular canal prism is economically undesirable. He estimates that under the completion of the $9,000,000 plan the possible speed of towing six barges of 300 tons each would be two miles per hour, and that the time between Buffalo and the Hudson River would be 7 days, while the time by the barge canal would be 5½ days, a difference of less than two days between the two different routes.

While it is true that the report shows the capacity of the barge canal would be 10,000,000 tons and the small canal 8,000,000 tons, both of these figures are very much in excess of the present needed carrying capacity of the canal, and which, even when the canal traffic was greater than now, was more than adequate to meet all demands.

The cheaper routes by way of Lake Ontario are objectionable because of the dangers incident to traffic on the lake, so that it is probable that but two plans can be examined and that but one of three courses is left for consideration. First, shall the canals be abandoned? Second, shall they be enlarged so as to permit the passage of 1,000-ton barges? Third, shall the improvement begun under the Act of 1895 be continued along the line of the route of both the Erie Canal and its feeders?

It may be well to consider here what advantage the canal offers in return for the money expended. Is it great enough to warrant the expenditure of this money, and is the commerce of the city of New York so much endangered that steps should be taken by the state at large to protect its present business and bring back the commerce which, it is claimed, has been lost?

In considering the decline of the commerce of the port of New York it is well to understand that the harbor facilities of Philadelphia, Baltimore, Newport News, Boston and Montreal have been greatly improved, and it is not to be expected that, notwithstanding anything that might be done to bring trade to our own port, there should be no increase in the business of these ports.

It is doubtful whether the inadequate canal facilities are entirely responsible for the relative decline in New York commerce. The terminal charges and dock facilities are not as desirable in New York as they are at the other ports, and in considering the question it is well to give due weight to these factors in the case.

I am, therefore, brought to this conclusion: First, that in the proposed improvement for 1,000-ton barges the advantages to be received are not commensurate with the expense involved. That the purposes for which the canals should be maintained are more for protection against unfair discrimination than they are for actual use. If this be true, it would seem that the smallest expenditure would be ample and that the enlarged barge canal recommended should not be adopted. It might be possible, by lengthening the locks and by changes of a similar character that larger boats might be used and more expeditious locking secured, as recommended under the modified plan of 1895. If that course shall be adopted, it is understood that the estimate of $19,000,000 will not be sufficient, and perhaps several million dollars should be added to the estimate.

It is your province to thoroughly consider the various plans proposed. It seems to me, however, that there can be no reasonable argument advanced for the barge canal as a competitor with the Canadian canals, because under the most favorable conditions we would still be as far from Liverpool, and the distance from the port of New York would still be several hundred miles farther than from Montreal. We can discard that part of the proposition, therefore, and consider the canal question as one more local than international.

I therefore recommend that the question of improving the canals along the line of the Act of 1895 be submitted to the people at the coming election, in the belief that it will meet with greater approval; that the expenditure can be more easily met and that it will serve all the purposes for which the canal was originally designed.

Gov. Odell displays so much sound sense and grasp of the situation in parts of the message from which the above extracts are made, that we regret the necessity of expressing total disagreement with his conclusions.

He deserves credit for pointing out that the canals can only be said to have proved a paying investment for the State of New York, if the matter of interest on the sums invested in them be neglected. It is true, too, as he suggests, that New York city cannot by any means in its power prevent the rival Atlantic and Gulf ports, for whose improvement both the Government and private capital have expended huge sums of money, from securing a large amount of trade that formerly went to New York. It is emphatically true, too, that to reach the real cost of canal transportation, the interest on the investment should be taken into consideration.

When it comes to presenting detailed figures, however, some unfortunate errors appear to have entered into the Governor's calculations. For example, he computes the interest charge on a large barge canal to be $3,300,000 per annum, and states that this will add .006-mill per ton mile to the transportation cost on a traffic of 10,000,000 tons. As a matter of fact, if we allow an average haul of 330 miles, such an interest charge as the Governor names would amount to just 1 mill per ton mile when distributed over a traffic of 10,000,000 tons.

Again, when the Governor estimates the interest charge which would have to be added to freight shipped over the canal when the "nine-million-dollar improvement" is completed, he assumes again an annual traffic of 10,000,000 tons. As a matter of fact, however, no one supposes that a 9-ft. Erie Canal, such as the Governor favors, could secure 10,000, 000 tons of traffic, or anything like it. If it carried a quarter of that amount, it would carry all that could reasonably be expected. Figuring on this basis, the "nine-million-dollar canal" does not appear so attractive by any means as in the Governor's computation.

Still again, it does not appear that, in either of these computations, the Governor has taken into account at all the cost of operating and maintaining these canals. Surely the taxpayers of the State have had enough experience to know that canals do not maintain themselves or run themselves by any means. The Governor's attempt to ascertain the whole cost of transportation by the proposed improved canals is praiseworthy. If he will revise his computation, put in all the elements of cost that enter into water transportation—those borne by the State, as well as those borne by the boat-owner—his opinion that the barge canal is not worth its cost will be strengthened, and his opinion as to the merits of the $20,000,000 improvement may suffer alteration.

On the other hand, while we have never been convinced of the merit of the barge canal as a commercial proposition, we must say that the Governor's selection of the most expensive route for the barge canal as a basis of comparison is unfair. He rejects the propositions for a barge canal route via Lake Ontario, where the estimated cost is only $50,000,000 to $52,000,000, on the ground that the danger of navigating the Lake would be too great. We believe he has given far too much weight to this feature, and that if a barge canal were to be built at all, the Lake Ontario route is to be preferred in any event. If a large barge canal were to be built, and to prove a commercial success, it would not be operated on canal-boat lines at all. The barges would be built so as to safely run to any ports on Lakes Erie or Ontario, or Long Island Sound, and the elimination of transfer charges would make this well worth while, in any event, whether the canal route ran via Lake Ontario or not.

The comparison which ought to be made, therefore, is between a canal route for 1,000-ton barges—built throughout in a first-class manner at a cost of $50,000,000, and a patching-up of the old Erie Canal, after the fashion of the discredited work of 1895, at a cost of $20,000,000. So far as we can learn, the unanimous opinion of business men and all familiar in any way with the conditions of the problem, is that between these two propositions, that for the $50,000,000 expenditure is infinitely to be preferred. In fact, the case ought to be stated still more strongly. For New York to spend $20,000,000 more to carry out the work that was planned in 1895 would be throwing good money after bad. If New York proposes to invest more money in canals, it should build a modern system. To spend nearly half what such a system would cost in patching-up the present obsolete old ditch, would be the greatest waste of State funds that has ever been recorded.

But the question which interests most of our readers, we presume, is that which heads this article. Not what ought the State to do with its canals, but what will the State do? The conditions appear to be such that this question can now be answered with a large degree of certainty. The present legislature, unless all signs fail, will not vote to submit to the people either the $20,000,000 canal proposition recommended by Gov. Odell, or any of the propositions for a barge canal. Even if they did this, any such appropriation would be overwhelmingly defeated by popular vote. The sentiment in favor of canal enlargement is confined to Buffalo and Troy and certain commercial

organizations in New York city, which are influential in molding public sentiment as it is reflected in the newspapers, but are powerless to move the great mass of the voters.

It is stated to be a fact that among the interests which have been most active in urging the expenditure of State funds for canal enlargement, are those in control of the grain handling facilities in Buffalo and in New York, whose excessive charges and exorbitant profits have done the most to divert grain trade from the port of New York. Naturally, these interests are anxious that the taxpayers of the State should spend money on canal improvements. A lessened cost of transportation across the State means bigger pickings for the toll-collectors at either end of the route.

Of course, we do not mean to say that all or even many of the advocates of canal enlargement are working from selfish motives solely. Many honestly believe, for example, that the canals can be made an effective agent to check by their competition excessive rail rates. This argument, indeed, assumes more and more importance as the end of the competitive era in railway transportation appears more clearly in sight.

For every voter who dreads the pressure of increased rail rates, however, there are twenty who can see the increased taxation due to canal enlargement as an actual drain on their purses. These are some of the reasons why it can be predicted with much confidence that for the present at least New York will undertake no large scheme of canal enlargement.

It will not, on the other hand, definitely abandon its canals. Indeed, it cannot without amendment of the State Constitution. Instead, it will pursue the course of maintaining them in their present condition for a few years longer. It will then be known whether the new "community of interest" plan in the railway field means increased rates of freight; whether the much-talked of diversion of traffic to Canadian routes is anything more than a myth; whether the United States is to actually undertake the proposed deep waterway from the Lakes to the Ocean.

Determination of any of these matters may make clear, two or three years hence, the course which New York should pursue toward its canals. Meanwhile these canals in their present condition carry a certain amount of traffic, and have some value, it is probable, as a lever to prevent the advance of railway freights. New York had better maintain them, therefore, expending as little as possible on their repair and maintenance until it becomes clearer whether their total abandonment or their radical enlargement is the wiser policy to pursue.

LETTERS TO THE EDITOR.

Prof. Shaler on Future Gold Production.—Correction.

Sir: In your issue of March 7, I find a statement concerning the future of gold production attributed to me. The facts of the case are as follows: In a regular lecture to a class in geology, a lecture not intended to be made public, I made certain statements concerning the future of gold production, particularly indicated by the working of placer gravels. From this lecture some student has taken certain statements, which, presented without the context, give a very inadequate idea of what I said. This unauthorized and foolish statement was, I believe, sold to the "New York Journal." As a busy man I cannot afford to deny statements which I find concerning my opinions which appear in disreputable newspapers. I am very much surprised, and not a little concerned, to find that such an unauthorized and presumably false statement finds a place in such a journal as Engineering News. I therefore ask you to inform your readers in some manner of the facts, which are in effect that the lecture was not a public lecture; the publication of the matter was not only unauthorized but contrary to the rules which govern decent students, and that, given without the text, the statements give an essentially erroneous idea as to my views concerning the matter. Yours very truly,

N. S. Shaler.

Harvard University, Lawrence Scientific School, Cambridge, Mass., March 14, 1901.

Concerning the I. H. Jewell Filter Co.

Sir: Replying to the letter of the New York Continental Jewell Filtration Co., published under the above heading on page 190 of your issue of March 14, I desire to present the following reply:

I deny absolutely the matters contained in the joint letter of my father, Mr. O. H. Jewell, and the New York Continental Jewell Filtration Co., under date of Feb. 20th, and challenge them to prove their statements. If they fail to do so it will show a plunge of thought, not justified by facts, which seeks to injure my business, and will turn the tables of accusation upon themselves.

I believe that my father of his own choice would not do this, but has erred in allowing the combination of filter companies (seeking to become a trust) to coerce him upon the assumption that he is but an employee now and must do as he is told or lose his job.

On Dec. 23, 1899, my one-fifth interest in the capital stock of the O. H. Jewell Filter Co. was sold, 900 shares being taken by Mr. Lorenzo Bull for the sum of $5,000, and the balance of 100 shares was transferred to my father so that he, in conjunction with my brother, would still maintain the controlling stock interest of the business. I, however, was to receive the dividends for all future time for this 100 shares of stock, unless sold, in which event the amount the stock would bring was to be paid over to me.

Shortly after this transaction, which was rather forced upon me by Mr. Wm. B. Bull demanding more company stock for himself or his father, Lorenzo Bull, under threat of possible foreclosure of company notes which they held, I set about to engage again in the filter business, at the same time that the above combination of filter companies were closing deals of organization.

I have now obtained enough patents to engage in the filter business for myself, and have shown to parties with whom I am dealing the value of these improvements instead of attempting to get business by representing myself as connected with the filter combination or their devices. But quite to the contrary, am seeking and hope to as far as possible enlighten the public upon the matters of my improved filter. So far as my financial standing is concerned, I do not regard their remarks as either pertinent nor important.

I know nothing of a filter company called the I. H. Jewell Filter Co., having never heard of it before, and if there is such a concern in the business, I will be glad to have my competitors inform me more fully concerning it. All of my business in filtration since the selling of my stock on Dec. 23, 1899, as above, has been conducted under my name individually. Yours truly,

Ira Hestren Jewell.

1623 Marquette Building, Chicago, March 16, 1901.

The Cassel Water Wheel.

Sir: The criticism of the Cassel impulse wheel which appeared in your issue of March 14 was undoubtedly made without a thorough investigation. The cuts published in your issue of Dec. 27 were made to illustrate the principle of the governing action and are not used as working drawings of the wheel. In actual construction the buckets are flanged and bolted on, and the shape of the rim of the wheel is such that ample strength to resist the twisting action, so much feared by the critic, is secured.

No indication of a tendency to be wrenched out of place has so far appeared in any of the wheels in use. In fact, there is no such tendency. The middle of the wheel is held in the plane of the center of the jet by the same means as are used in other impact wheels. It can be thrown out of line only by moving the shaft itself. The buckets are similar in design to those on other impulse wheels and the water is turned back at a similar angle, and it does not reverse itself upon the other buckets. The housing does not differ from that used with most impulse wheels and takes care of the water in exactly the same way.

Taking other impulse wheels with their governors as a basis of comparison, the Cassel is not only not complicated, but is exceedingly simple and has fewer working parts. A comparison with the price lists of other wheels with their governors shows that it is not more expensive.

An examination of a finished wheel in use will show that the charge of mechanical weakness is unfounded.

The governing mechanism, while sensitive, is exceedingly powerful and is so placed that no water in motion can reach it. Consequently it is not subject to the erosive action of the jet. The buckets are subject to that action as in all impact wheels. The power of the wheel is not transmitted through the governing mechanism any more than the power of a steam engine having a flywheel governor is transmitted through the governing mechanism.

The point made that when the wheel is closed, the action of the jet splitting on the wedge-shaped buckets tends to keep the wheel closed, is well taken. There is just such a force then, but it is comparatively small and is counteracted largely by the return action of the water on the outside of the bucket. The governing action has proven itself strong enough to handle that force easily.

I have no doubt that under the conditions existing at Snoqualmie Falls a much smaller variation could be obtained with the Cassel wheel than has been secured with the apparatus there in use.

The Cassel wheel was not intended to revolutionize the water-wheel business. It is a simple mechanical invention and it has proven itself capable of handling extreme variations in load more satisfactorily than any other form of governor.

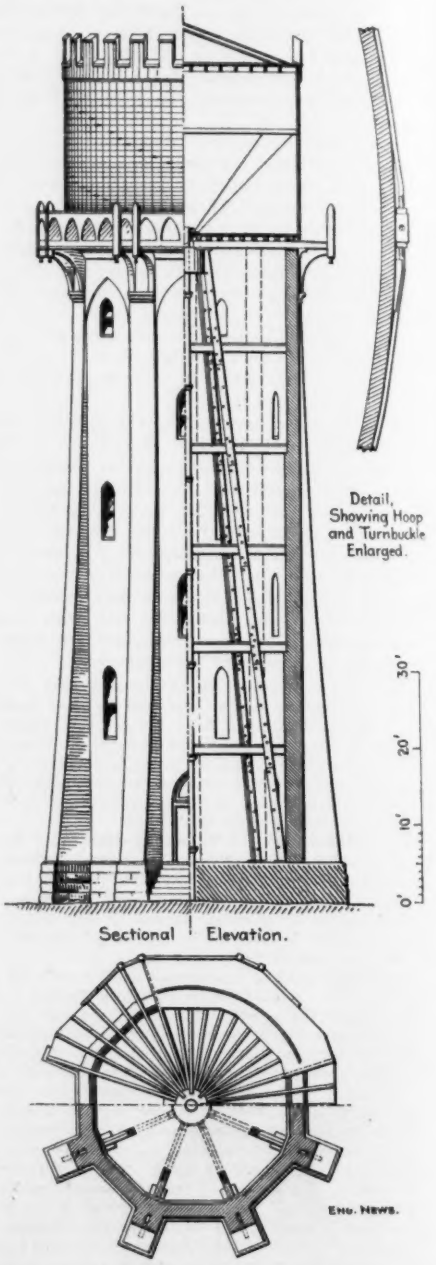
The disastrous experience of the Snoqualmie F... Power Co. in trying to govern by throttling the w... goes to prove how difficult it is to govern by that m... with the comparatively low head of 260 ft. At hi... heads the difficulty may be said to increase about as square of the head.

American engineers who have examined the wheel ... all spoken highly of it. The fact that Mr. Cassel ... present installing about 30 of these wheels in Switz... would indicate that the Swiss engineers regard it ... favor also. Geo. E. Montandon, C. ...

Everett, Wash., March 9, 1901.

Suggestions for an Elevated Wooden Water Tank.

Sir: The failure of a small water tank at Paterson, ... J., described in your issue of Dec. 27, 1900, is one of a ... limited number of such instances, compared with the fa... ure of stand-pipes, and this one was due to the failure ... the metal, not of the wood.



Suggestions for an Elevated Wooden Water Tank.

Builders of wooden stave pipe have used round bands almost from the start, and the reason why they are better than flat hoops apply equally to tanks.

Tanks of wood are cheaper, more easily erected, give better protection from the effects of frost and ice, and properly built are as durable as metal. I have seen in a steel stand-pipe, disused about three years, an accumulation of rust fallen from the sides which I estimated at fully two wheelbarrow loads, and there was more where that came from.

As for water towers against stand-pipes, the value of either is in its elevation. Depleted, the stand-pipe takes time to fill. The water tower becomes of value as soon

as water enters it, and a large quantity can be stored at the desired elevation more cheaply and securely than by a stand-pipe of equal diameter.

Of the different supporting structures for such tanks, the writer ventures a description of one devised by him with a view to less cost than bids received for stand-pipe and for steel tower, and which proved cheaper. Soon after its erection it withstood without damage a storm which destroyed considerable property in the vicinity, and which it was thought would have wrecked a stand-pipe; its success in every way may make it of interest to others.

The plans and elevations need little explanation to engineers, who would naturally modify them in accordance with dimensions and material used, as well as by their views of appearance.

They show an octagonal tower of brick 80 ft. high, with buttresses at each corner; 28 ft. of 26-in. wall, 26 ft. of 21½-in., and 26 ft. of 17-in.; full tank gives pressure of about 7,000 lbs. per sq. ft. of top of wall; pressure at base of tower, about 11,000 lbs. per sq. ft.

Of the weight of the tank, about 225 tons is carried directly by the walls and center support, leaving about 325 tons to be borne by 40 deck beams, 7 × 12 ins., 10 ft. between bearings.

Eight inclined posts of 6x12-in. timber, doubled, carry the ring supporting the inner end of the deck beams. The load on each post is 18 tons, making a pressure on the reduced ends of about 300 lbs. per sq. in. The floors are supported by these posts, and in turn give them the required stiffness; in connection with the corner buttresses they also act as wind braces.

The tank is of wood, 30 ft. inside diameter, with 24-ft. staves. The weight of the deck and full tank is 550 tons; capacity, 115,000 gallons; top covered with level floor, with screened ventilators. Wind braces are suggested in very exposed localities.

For tank hoops I propose 1-in. round steel. These would be probably most conveniently made and used in four lengths to each hoop, all being of equal length and interchangeable.

The ends would be upset for threads, giving full strength. For joining, I suggest turnbuckles, with right and left hand threads. The turnbuckles would be round, with hole in center for turning. The tangent of the band made by the turnbuckle would be filled by small iron wedges, giving a uniform pressure on the tank and guarding the bands against the straightening effect of the turnbuckles on the slightly bent ends.

It is argued that cinch strains do not increase the total strain on the bands, but the swelling of the wood may. Allowing 1 ton of such strain on each hoop or band, 36 hoops, spaced from 4-in. centers at the bottom of the tank to 12-in. at top, would keep the whole strain within 12,000 lbs. per sq. in.

The cost of such a tower and tank, here, aside from contractor's profits and ornamentation, would be about $8,000. This does not include foundation, which would vary with locality. G. W. Pearsons.

1611 Baltimore Ave., Kansas City, Mo., Jan. 15, 1901.

Engineering and Other Matters in Rhodesia and Matabeleland.

Sir: In August last I severed my connection with the Bulawayo town council, and am at present surveyor to the Ayrshire mine in the Lomagunda district of Rhodesia. Bulawayo is likely in the near future to become a fairly busy town, being the center and only town in Matabeleland. It is in direct communication with Cape ports by rail, and when the country settles down to business again after the war it is likely to be connected with the Transvaal by rail via Geelong, Guli and Pietersburg. The latter town is at present a terminus of the Transvaal railways, and the Rhodesia railways have authorized a line to Geelong. Bulawayo is at present considering a bond issue o £110,000 for street and town improvements. It may be mentioned that this is the first loan undertaken by Bulawayo. When the country settles down again a scheme for a water supply for Bulawayo must come along as a natural consequence. The town is at present supplied by shallow wells in the Alluvium, which are rapidly becoming contaminated. The control of the town's water supply was given out to concessionaires by Dr. Jameson when he was administrator of Matabeleland in 1894-5, Willoughby's Consolidated Co., Bulawayo, being the favored firm. They have, however, entirely failed to supply the town with water, and to carry out the terms of the concession, so that the latter can be cancelled at any time. I think Bulawayo has had enough of concessions and will devise and carry out its own scheme in the near future. Here are some of the conditions: A town 1,300 miles from a seaport; freight charges, 15 shillings ($3.60) per 100 lbs. No pipe foundries in South Africa. The shortest pipe line of the schemes considered as yet is 8 miles long, while the street mains would require double this length. Much light wrought-iron pipe would also be required for distribution.

When I was assistant town engineer I suggested to my chief the idea of adopting wood-stave pipe for the future water-works on American lines. Referring to the paper on wood-stave pipe, which was read before the Am. Soc. C. E. some time ago and reprinted in Engineering News of Oct. 27, 1898, I calculated an experimental length which met with approval and which had I stayed at Bulawayo would have been built.

We are very badly served for timber in this country. The only wood available near Bulawayo is an inferior kind of teak, locally called redwood. It is very liable to twist and shake when exposed to the weather and is very brittle; but this being the only wood, I intended to experiment, and expected success to come, if at all on the saturation theory, i. e., having the staves thin enough to be always saturated. On leaving Bulawayo I handed all my sketches, calculations and other information to Mr. Jno. Laughton, the town engineer, who promised to carry out the experiment mentioned above and to make investigations concerning comparative costs, etc.

Things in Rhodesia are developing very slowly. A few years ago a narrow-gage railway was laid from Beira to Salisbury, which has just been taken up and replaced by a 3-ft. 6-in. gage (the standard gage in South Africa). Salisbury is seriously thinking of plunging into a waterwork and electric lighting scheme, and have called in Mr. Thos. Stewart, M. I. C. E., of St. George's Chambers, Cape Town, who is preparing plans.

We have here a good many mining properties which would make good 8 dwt. propositions, but between heavy working expenses and heavier incidentials it is a hard job to engineer them to pay a 10% dividend in the present undeveloped state of the country, with high white wages, bullock wagon transport and native labor problems.

Witwatersrand (or The Rand) has been well known as an American market for some years past, especially for such firms as Gates, Fraser & Chalmers, Worthington, etc. This country is a good market for the American canning industry, all kinds of canned foods being imported in large quantities, but "smart Yankee notions" are conspicuous by their absence. Instead of seeing a prospecting shaft run down with a light friction clutch-horse gear, we generally see four natives struggling with a very ancient winch. I know of a mine where the battery is supplied by winches, and natives carry the ore in boxes on their heads from the shafts to the feed-hopper. Such things as good modern pulleys, ball-bearing jacks, horse whims, light trucks and portable railway sets and generally what might be termed mining accessories ought to find a good market here if managers and others could dismiss prejudice and show enterprise. Yours faithfully,

Jno. H. Veasey, Stud. Inst. C. E.

Ayrshire Mine, Lomagunda District, Rhodesia,
Jan. 19, 1901.

Desirability of Abandoning Sand Tests of Cement.

Sir: Referring to the letter in Engineering News of March 7, 1901, by Mr. Pitson J. Cleaver on "Desirability of Abandoning Sand Tests of Cement," the writer would beg to state that he cannot entirely agree with the views therein expressed.

The neat test for determining the strength of cement is, as it is commonly employed, deficient for two reasons; first, because of the coarse inert matter which is contained in nearly all cement; second, because the test does not give directly the information desired

As to the effect of the inert matter, the presence of this material renders all so-called neat tests in reality a species of sand tests. As is generally known the coarsely ground particles (in contradistinction to the impalpable cement powder) are inert, i. e., possess no cementing value. It is also known that, up to a considerable amount the greater the proportion of these coarse particles, the greater will be the strength of the so-called neat mortar; or vice-versa, the greater the proportion of active material, the lower will be the strength of the neat mortar. The test, therefore, favors the coarser cements.

As to the second deficiency in the neat tests for strength, this test does not give the information generally desired because it gives simply the cohesive strength of the material, while what is desired is knowledge of its cementing properties—the combined cohesive and adhesive strength as developed in sand mortar.

The sand test for strength does not possess the above defects. It gives the required strength directly. It is a correct index to the proportion of active material contained in the cement; for as this proportion increases, so does the strength as developed by the sand test. This test is in itself a test for fineness which cannot be equalled by the sieve test for that quality; for in spite of Mr. Cleaver's expressed confidence in the sieve test, it seems to be generally recognized that this test is a very unsatisfactory one. The trouble is that sieves cannot be made sufficiently fine to separate all the inactive particles from those which are active. The finest sieve obtainable appears to be that known as the 200-mesh sieve. As Mr. Cleaver states, all the material which will not pass that sieve may be considered inert. There is no reason to conclude from this, however, that no inert material will pass the 200 sieve and undoubtedly much does, the proportion may be large or small, but in any event, the sieve test has reached its limit with the sieve in question and can tell us no more. The combination of neat test for strength and sieve test for fineness therefore cannot be considered satisfactory, and would seem to the writer to be decidedly inferior to the sand test. The generally unsatisfactory character of the sieve test has been brought out by the progress report of the American Society of Civil Engineers' committee on cement testing as reviewed in an editorial in Engineering News of June 21, 1900.

In practice the neat test for strength has some advantages which will recommend it. It is the more convenient test to apply as it requires fewer materials; it is more easily manipulated than the sand test and no doubt gives more consistent and satisfactory results in inexperienced hands than does the sand test. Also, the results obtained by different experienced operators generally agree more closely in case of neat tests. While the neat strength is not precisely the kind of strength desired and the results not entirely consistent, as pointed out, the test still gives a valuable indication of the strength required and of the value of the cement. In the ordinary testing work, where it is only desired to know that the material is running uniformly in strength or to detect any large variations in the same, and also in cases where proper sand is difficult to obtain, the neat test may perhaps be applied to better advantage than the sand test and be quite satisfactory.

On the other hand, the sand test is not difficult to manipulate and when properly applied certainly would seem to give better and more satisfactory results. In determining the real value of the cementing strength or the comparative strengths of different cements, it would seem to be pre-eminently the test to employ, and one which the neat test even with sieve test combined cannot supplant. It would, therefore, seem that whatever be done with the neat test the sand test cannot well be dispensed with.

In regard to the argument advanced against sand mortar, that it will not indicate the soundness of a cement even with considerable excess of lime, the writer would state that while it is true that neat mortar will show the effects of unsoundness more quickly than will sand mortar, the latter will also show these effects in time; otherwise wherein would lie the evil of the use of unsound cement, since it is invariably used in sand mortar? As a matter of fact, the writer recalls many cases in his own practice where sand pats and briquettes have swelled and disintegrated, and in a very short time too. However, the neat test, being more susceptible to disintegrating influences, is the proper one for soundness when applied to pats or thin cakes. This does not detract from the value of the sand test for strength, having nothing to do with it, nor is there any reason that the writer can see in making neat tests for strength simply because neat tests are applied for soundness, as an entirely distinct set of test specimens must, or should, be made up for each of these tests. Respectfully,

Allan W. Carpenter,

Jun. Am. Soc. C. E., Asst. Engr., N. Y. C. & H. R. R. R.
New York, N. Y., March 13, 1901.

Notes and Queries.

J. S. T., Newark, N. J., desires the address of some manufacturer of large balloons in New York city or vicinity.

W. J. G., Port Huron, Mich., writes:

Does any reader of Engineering News know of a foreign or domestic traverse table giving latitude and departure to five significant figures for every minute of the quadrant and for distances from 1 to 10, or from 1 to 100.

"Average Area," Buffalo, N. Y., writes:

I read with interest the various communications on prismoidal corrections as applied to earthwork computations. It would be interesting to know in this connection what the general practice on railway work is. I venture the assertion that 90% of all earthwork is calculated and paid for by the average end area method.

THE METROPOLITAN UNDERGROUND RAILWAY of Paris was opened to traffic on July 19, 1900, on the line extending from the Porte de Vincennes to Porte Maillot, an almost straight line east and west through the center of Paris, 6.6 miles long. Up to Dec. 31, 1900, this line transported 15,171,339 passengers, and the gross receipts were $513,857. Commencing in August with 1,703,301 passengers, 3,447,241 passengers used the line in December. Of the total of passengers 12,125,353 traveled second-class; and only 1,767,758 took return tickets. The price of tickets for the three classes is 5 cts. for first class, 3 cts. for second class, 4 cts. for return tickets on second class before 9 a. m., and 1 ct. for school children traveling with a teacher. The operating company pays the city of Paris 2 cts. on all first-class tickets, and 1 ct. on second-class and return tickets. "Le Genie Civil" compares this traffic, per mile per year, with that of other similar lines as follows: For the last four months of 1900 the Paris movement was equivalent to almost 6,000,000 per mile per year; the annual movement on the Metropolitan of London does not exceed 4,839,000 per mile per year; that of Berlin, 4,510,000 per mile per year; and that of the Manhattan Railway of New York, 5,000,000 per mile per year. Our contemporary, however, seems to lay little stress upon the comparative length of lines in these comparisons. The London electric underground, opened on July 30, 1900, up to Dec. 31, 1900, carried 14,500,000 passengers.

THE GASOLENE ENGINES for the seven Holland submarine torpedo vessels now being built for the U. S. government are described and illustrated in the "Journal of the American Society of Naval Engineers" for February. The specifications for these engines require them to be of the four-stroke cycle type with four single-acting cylinders, and the engines must be so balanced as to prevent excessive vibration; 160 HP. must be delivered at 360 revs. per min., consuming not over one pint of gasolene per brake HP. hr. The speed of the ship at full power must be 8 knots per hour. The contract for the engines was

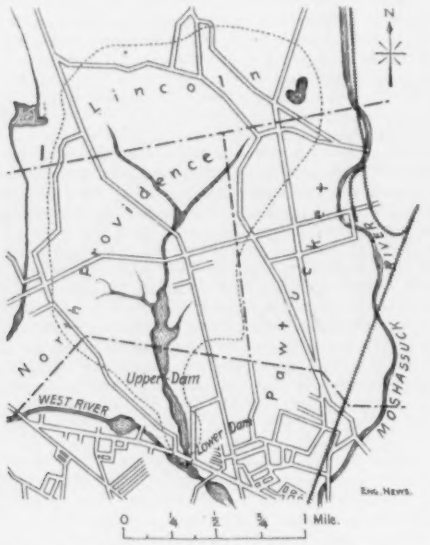


Fig. 1.—Location of Dams at Providence, R. I., that Failed on March 11, 1901.

given to the Otto Gas Engine Works, of Philadelphia, and the first machine delivered by them was tested on Dec. 20. In a brake test the engine delivered 160.4 HP. at 322 revolutions, using 0.88 of a pint of gasolene of .75 specific gravity per HP. hr. At 360 revolutions the engine developed over 190 HP. The engine ran smoothly with no vibration, the only objectionable qualities being the heat and noise from the exhaust. The bearings, which are of phosphor bronze, showed no signs of heating.

THE PEARY ARCTIC CLUB, of New York, is planning to send an expedition to the north to find the "Windward," the Arctic relief vessel which sailed from Godhaven, North Greenland, on Aug. 20, 1900, with Mrs. and Miss Peary on board, in search of Mr. Peary. Since the date named nothing has been heard of the "Windward." The last information received from Mr. Peary was dated March 31, 1900; but he understood that if he did not return with the "Windward" in 1901, a steamer would be sent after him in 1902. Mr. Morris K. Jesup is President of the Peary Arctic Club. The steamer to be sent out will be the fifth vessel chartered by this organization and sent to the polar regions.

THE PROTECTION AGAINST PITTING afforded by a thin coating of scale in a boiler is illustrated by an incident related by Mr. J. E. Terman in "The Boiler Maker." Three boilers were using feed water contaminated by acids and other impurities, caused by drains from manufacturing establishments emptying into the source of supply. They had been in service about six months and the interior surfaces were covered by a very light coating of hard scale. Upon examination it was found that two crescent-shaped pits had formed on the inside of the shell of each boiler about 6 ins. from the lower manholes in the front heads. It was found that these were the points where the manhole covers would touch when knocked into the boiler. The fireman was, therefore, cautioned to let those heads down very carefully when removing them, and the corrosive action then apparently stopped at once. The coating of scale was hardly thicker than writing paper, but seemed to effectually prevent corrosion. Boiler tubes often wear through rapidly where internal feed pipes are allowed to rest upon them. Such pipes should be hung from the braces or shell.

THE TUNNEL OF THE YAK MINING, MILLING & Tunnel Co. is nearing completion, being now 9,600 ft. long. This tunnel starts a little way up California Gulch, near Leadville, Colo., and bores its way through some of the best gold and silver-lead producing territory in this camp. Mr. W. H. James, of Denver, is at the head of the enterprise.

BICYCLE SIDE PATHS have been built in Babylon, L. I., under direction of Mr. Eugene R. Smith, Jun. Am. Soc. C. E. The path is located inside the grass-border between the sidewalk and the roadway, where the gutter formerly ran, and the gutter is moved inward. The path is 6 ft. in width and is given a slope of 1 to 2 ins. in this width toward the gutter for drainage. A sod curb 1 ft. wide is made between the path and the gutter, and is given a slope of 1 vertical on 2 horizontal, its upper edge being level with the side path. Thus, any water falling on the side path drains at once to the gutter. The material used for the path itself was the natural earth only. The area to be taken for the path was first ploughed and where necessary to get a sufficient elevation it was filled higher with loam, then raked and rolled if necessary to get a uniform density of the material. In swampy places the lower part of the fill was entirely of sand in order to give a safe foundation in case of frost or heavy rain. Over the loam a covering of sand about 1 in. thick was spread, and also rolled in. The loam packed and gave stability to the path, and the sand mixing with the loam formed a surface which was hard, easily drained and free from mud. The proportions of sand and loam for this surfacing was found to be an important matter and experience demonstrated that the sandy ingredients should be as large as possible without permitting the path to grind up and lose its hard surface during a summer drouth. The cost of these paths has varied from $192 to $765 per mile. The work was done by the day, at the market rate for labor and material. The lower figure indicates the cost where all the material has been obtained from the road itself without being hauled, and the larger amount is the cost where all the earth, principally loam, has been brought a long distance. In the sections where but small quantities of loam have been required and there has been but a short haul the cost has been $415, $447 and $462 respectively per mile. The annual cost of maintenance has thus far been $38 per mile, but this price is derived from the experience of but one year on about four miles of path.

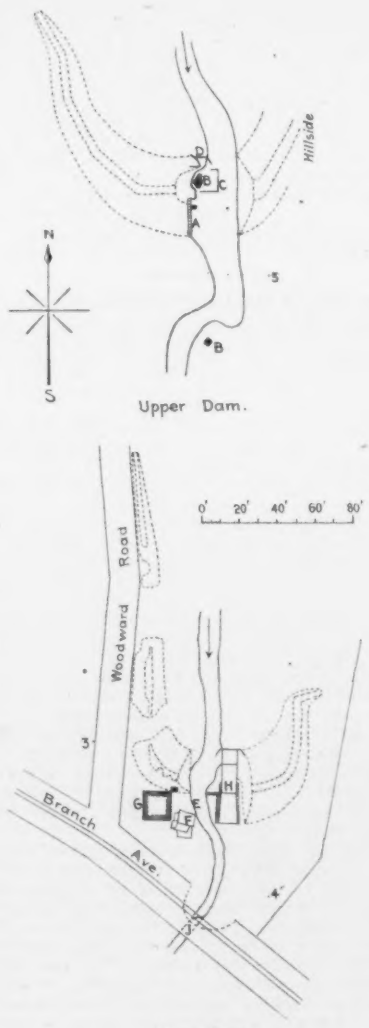


Fig. 2.—Sketch Plans of Breaks in Dams at Providence, R. I.

Broken lines show existing earthwork.

Notes to Upper Dam.

A = masonry in places.
BB = detached masonry.
C = timbers of west side of flume, fallen to the east.
D = plank sheeting and timbers in place, but disturbed.
(5) = point of view of Fig. 5.

Notes to Lower Dam.

E = original position of wooden building on dam.
F = wreck of wooden building.
G = old stone mill.
H = flume.
J = south half of arched culvert (balance wrecked).
(3) = point of view of Fig. 3.
(4) = point of view of Fig. 4.

THE FAILURE OF TWO EARTH DAMS AT PROVIDENCE, R. I.

By Ernest H. Brownell, Assoc. M. Am. Soc. C. E.

Two dams located near the northern boundary of the city of Providence, R. I., failed on March 11. The dams are on a branch of West River about one-third of a mile apart. The upper one formed a pond of about 15 acres, with a drainage area of about 1,400 acres. There was a pond of about eight acres between the two dams, with an additional drainage area of about 50 acres, making a total of 1,450 acres of drainage area tributary to the lower dam.

Fig. 1 is a map of the drainage area involved, based on the topographical map for this section

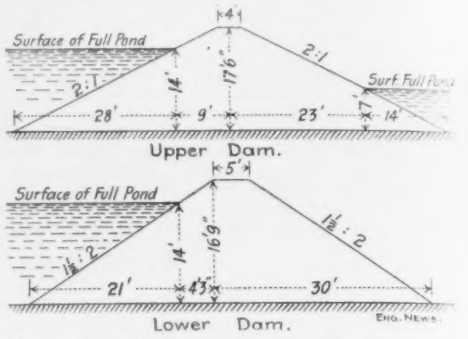


Fig. 6.—Cross-Sections of Dams at Providence, R. I., that Failed on March 11, 1901.

(From Report of the Rhode Island Commissioner of Dams and Reservoirs for the year 1884.)

published by the U. S. Geological Survey. The sketch plans, Fig. 2, show the breaks in the two dams, plotted from measurements by the writer. Figs. 3 and 4 are views of the break in the lower dam, and Fig. 5 is a view of the break in the upper dam.

The water from the lower dam emptied almost immediately into West River, down which it flowed about a mile to the Moshassuck River, entering it at a point about a mile and a-half above the business center of Providence.

The old stone mill at the lower dam was built in 1816. The dams were probably of the same age, originally, but have been rebuilt and repaired at various times. The report of the Rhode Island Commissioner of Dams and Reservoirs for the year 1884 (dated Jan. 1, 1885), gives cross-sections of these dams, and details of their flumes. The cross-sections are reproduced here as Fig. 6, to which reference may be made for dimensions.

There have been some changes made in cross-section since 1884, but probably nothing materially affecting the disaster as it occurred, excepting some filling, the top of the embankment of each dam being now from 7 to 10 ft. wide.

The difference in normal water levels above and below the upper dam was 7 ft., and for the lower dam 14 ft.

Through the center of the upper dam was a timber flume, extending the entire depth and width of the dam, and having side walls of uncoursed rubble masonry 2 ft. thick. This flume was fitted with the necessary roll-way, apron and gates. It was 8 ft. wide. There was a flume in the lower dam similar to that in the upper dam, but 16 ft. wide.

In the text of the report of the Commissioner of Dams and Reservoirs for the year 1882, the lower dam is described as being 600 ft. long. It is stated that "in all times of high water it should receive careful watching." In the report for the year 1884 the commissioner refers to the two dams as follows:

Stone Mill on Randall Privilege on Branch of West River† (Lower Dam.—Ed.).

The dam at this privilege is composed entirely of gravel and sand in sufficient quantity for its safety under ordinary circumstances; and probably no event other than an overflow of the embankment would cause its destruction. A rise of water 2¾ ft. above the surface of full pond would cause such overflow.

The commissioner is informed, however, that the stream is not subject to excessive floods, and that the water can at all times be controlled by the means provided for the purpose.

*107 Westminster St., Providence, R. I.

†It may save confusion if it is here noted that the ponds were sometimes called "Randall's Pond" or "Randall's Mill Privilege;" also "Upper Canada Pond" and "Lower Canada Pond."—Ed.

Upper Reservoir (on Branch of West River).

The last-described dam is a co-relative of the one at this reservoir, and flows the water back upon its base to the depth of 7 ft.

The material composing the two dams is very similar, and so are the forms of the structures.

The width of each on the top would seem to be slight; they are, however, amply sufficient to successfully resist the pressure of still water at full pond.

Should the water approach near to the top of the dam, and at the same time be excited to violent waves, they might find the way across the dam and cause its destruction.

The sudden escape of the combined waters of the two reservoirs would be seriously felt in the city. The attention of the proprietors was early called to these structures, and the reply returned was that both structures were diligently watched and guarded at all times of high water.

In the report of the commissioner for 1895 it is stated that the city of Providence has complained of "the unsafe condition of the bulkhead gates" and the "general unsatisfactory condition" of the lower dam. The commissioner says the dam

will continue to be a menace to the city of Providence as long as it stands and the proprietors should be induced to erect a modern dam some 500 ft. up stream. The pond is no longer used for power at the Randall mill, but simply as a reservoir for water used at the Allen's print works.

FIG. 3.—VIEW OF BREAK IN LOWER DAM FROM WOODWARD ROAD.

FIG. 4.—VIEW OF BREAK IN LOWER DAM AT RIGHT OF FLUME.

FIG. 5.—VIEW OF BREAK IN UPPER DAM, FROM BELOW.

In 1895, the proprietors were notified by the commissioner to keep the water at the lower dam several feet below the normal level; or to keep it down to the level of the top of the dam as it existed before a certain raising which occurred prior to 1885.

Both dams are reported to have been built of fine gravel and sand. I find only quite fine, clean sand at the greatest breaks (most of the grains of sand are about 0.01-in. in diameter).

There was a fairly heavy rainfall on March 11, the day of the failure. The storm began at 1 a. m. Up to the time of the accident the rainfall was by the city engineer's observations, approximately:

				Ins.	Total ins.
1	to	7	a. m.	0.25	0.25
7	"	8	" "	0.09	0.34
8	"	9	" "	0.22	0.56
9	"	10	" "	0.49	1.05
10	"	11	" "	0.35	1.40
11	"	12	" "	0.35	1.75

I have not seen any witness of what occurred at the upper dam, but the following seems to me to be the probable action of the water.

The drainage area being frozen, and all located near water courses or roads with gutters, and the slopes being comparatively steep, the water must have collected in the upper pond with great rapidity. Ice jamming in the wasteway probably helped to raise the level of the water, as this way was only 8 ft. wide.

The position of the break at the upper dam, the side wall still partially standing on the west side of the flume, and the timbers of the west side fallen over to the eastward, all indicate that the break occurred on the east side of the flume, possibly right against it, although there were precautions in the way of sheathing to prevent water following the wall.

The intact condition of the top of the upper dam everywhere except at the break indicates that the overflow was not general, possibly there was no overflow at all. The frost has gone down over 4 ft. here this winter, the top of the dam was narrow, and the water may have gone through material disturbed by frost. There is no special reason to think that there were waves acting on the dam. The wind was variable, but mostly from the east, although at the time of the disaster it was more nearly from the north.

The flume at the upper dam was practically all washed out. The break was 82 ft. wide at the top. A block of masonry 2 × 6 × 6 ft. was carried about 150 ft. down stream.

This was shortly after noon, for at 12.30 the water was first seen coming over the lower dam, which was soon overwhelmed. The widely-distributed breaks in the lower dam show a general overflow. There is a small stone mill at the foot of the dam, and next to it was a wooden building, resting partly on the dam. The latter was a total wreck. Of the nine people in the building, all but one were saved; an interesting feature being the saving of three by the fire department, using ladders over the break.

The flume at the lower dam withstood the flood, but 15 ft. of the length of the dam to the east of it was washed out, and 45 ft. to the west. There were two other breaks (of about 40 ft. and 75 ft.) in the west wing of the dam.

The water flooded several acres on the south and west of the lower dam. It washed out the street badly, wrecked half of an arch culvert, broke a gas main, and left the car tracks hanging. It displaced the foundations of a highway bridge a quarter of a mile down river, and flooded the lower floor of a bleachery a mile below.

It was recognized as early as 1882, as shown by the quotations already given, that the only safety for these dams was in careful watching. Mr. W. C. Simmons is now State Commissioner of Dams and Reservoirs.

A SMALL WATER-WORKS PLANT AT TROTWOOD, O., WITH STORAGE UNDER COMPRESSED AIR.

By Benj. H. Flynn.*

Trotwood is a small unincorporated village in Montgomery Co., O., a few miles northwest of Dayton, having a population of 214 by the census of 1900.

A very disastrous fire in 1898 was responsible for the installation of a water-works in this village, the smallest in Ohio to be so provided. The plant was completed in 1899, and was intended at first for fire protection, only, but now the water is being used for general purposes.

As the village is not incorporated, a plant could not be put in by the village, nor could a franchise be granted to a private company. To overcome this difficulty a stock company was formed, including nearly every citizen of the village, and shares sold at $40 per share until $3,100 was

*Engineer Ohio State Board of Health, Columbus, O.

raised, enough for the installation of the plant complete. The mains were put down in county and township roads, simply by sufferance, no written permits or franchises having been secured from either the county commissioners or the township trustees.

The water supply is secured from two 8-in. wells, driven 26 ft. through clay and hardpan and into a bed of gravel. The water stands in the wells 12 ft. below the surface, and the level was lowered but little by pumping at the rate of 120 gallons per minute, indicating sufficient water for this small place. The water is pumped direct from the wells to a horizontal steel tank by a vertical duplex power pump, run by a gasoline engine. The tank, engine, pump, and wells are all within the confines of a neat stone building, situated at the edge of the village.

The pump was made by C. O. Lucas, of Greenville, O., and is fitted with a device by which a certain amount of air can be pumped with the water to the tank, and there under pressure force the water through the mains when the pump is not running. The pump is a double-acting one with 6 × 12-in. cylinders, and has a capacity of 175,000 gallons in 24 hours,, working under a pressure of from 40 to 80 lbs., the limits allowed in the pressure tank. This tank is 24 ft. long, 5 ft. in diameter, and holds 5,000 gallons. It is fitted with a blow-off cock for the regulation of the pressure and the amount of air above the water.

There are 1,800 ft. of 4 and 6-in. mains, fitted with nine fire hydrants, giving fire protection to all of the village and about 75% of the same access to the water for private use. There are 22 service connections to the mains, 16 of which are for sprinkling, only, and in use for but six months of the year. None of the services are metered.

The pressure in the tank is run up to 80 lbs., then allowed to fall to 40 lbs., before pumping again. On account of the few connections to the mains the pump has to be run not oftener than once a day, and then only for a short time.

This is the only case in Ohio where the compressed air system is used in a public water supply, though several institutions have made use of it. This community has supplied itself with an efficient fire protection, together with all the advantages of a public supply, at a per capita cost much below the average for this section, and has furnished an example which might be copied by many other small places.

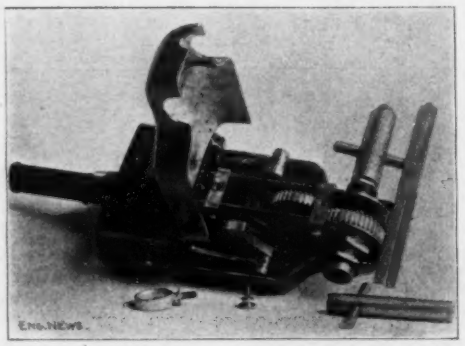
At the present time the private well supply of Trotwood is not particularly objectionable for domestic use, and the sanitary advantage is not so evident, but in many places this would be of the greatest importance.

A REVERSIBLE PNEUMATIC MOTOR.

Many different types of compressed air motors have been devised for operating drills, reamers, and other small tools, and much ingenuity has been exercised in the attempts to make them as light and as adaptable for use in confined places as possible. They should be, also, economical of air and easy to control. The motor herewith illustrated has been designed upon somewhat novel lines.

As will be seen, the spindle is placed in the extreme end of the motor in order that the latter may be used in very close quarters. The aluminum casing has a hinged lid which may be opened to inspect or oil the gears and cylinders. The latter are made of bronze and are of the oscillating type and double acting. The trunnions are provided with steel ferrules to protect them from wear. In the main frame there are two air chests, one for live and the other for exhaust air, and by turning the handle half way around the functions of these chests become reversed, thereby reversing the motor. By a one-quarter turn the motor is stopped. The air is admitted and exhausted through the handle, which is provided with an adjustable collar that may be set to allow the motor to run one way only. A detachable handle is provided for use when the machine is suspended or used for tapping or reaming.

The largest motor of this type at present built weighs 33 lbs. and develops about 2 HP. with 90 lbs. pressure, consuming about 17 cubic ft. of free air per minute. The maximum speed of the drill spindle is about 200 revs. per min. under 100 lbs. pressure. The speed can be controlled by the handle or a throttle.



A Reversible Pneumatic Motor.
Made by the Helwig Mfg. Co., St. Paul, Minn.

For the information here given we are indebted to the Helwig Mfg. Co., of St. Paul, Minn., the manufacturers of the motor.

ANNUAL MEETING OF THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION.

The second annual meeting of this association was held at the Auditorium Hotel, Chicago, March 12, 13 and 14, and was largely attended by representative men from all parts of the country. On the whole the meeting was a successful one and promised well for the future of this new association.

The first session was called to order about 10 a. m. on Tuesday, the 14th, and the President, Mr. John F. Wallace (Ill. Cen. R. R.), delivered the annual address, an abstract of which we gave last week, together with abstracts of three of the committee reports. Some abstracts of additional reports are printed on another page of the present issue and the following is a general account of the proceedings: Only one of the 14 committees failed to make a report, and that was the committee on "Buildings." The chairman (H. W. Parkhurst, Ill. Cen. R. R.) announced that a mass of material had been obtained, but there had been no time or opportunity for the preparation of a report. The appointment of a committee on "Clearing Snow" was suggested by Mr. W. McNab (Grand Trunk Ry.).

ROADBED.

The Committee on Graduation, which we printed last week, was the first to present its report. The chairman, Mr. W. McNab (Grand Trunk Ry.), pointed out that the term "graduation" was incorrect, and as the term "grading" has too limited a meaning he suggested the term "roadbed" as being more accurately descriptive of the work included in the committee's investigations.

The report recommended a width of roadbed of 20 ft., but several members considered this excessive, 18 ft. being thought sufficient, and saving expense which might better be invested in heavier rails, additional ballast, etc. Mr. Wallace (Ill. Cen. R. R.) pointed out that 20 ft. gives room for the men to stand and for ties to be laid without falling down the bank. The width should be uniform for both cuts and banks, and this is now the standard practice of the Illinois Central R. R., using a width of 20 ft. He thought it best to make the banks of full width in first construction. Mr. Dougherty (Ill. Cen. R. R.) explained that the bottom width of the ballast is 15 ft., and with a roadbed of less than 20 ft. there is difficulty in keeping the ballast in place. Mr. Geo. W. Kittredge (C., C., C. & St. L. Ry.) said that in a cut-off recently built he had used a width of 16 ft. on banks and 24 ft. (between ditches) in cuts. This was done for economy, the width of banks being eventually 20 ft. It is easier to widen banks than cuts, and the widening will be done gradually with the strippings from gravel pits. Great economy in maintenance sometimes follows from widening 15 or 18 ft. cuts to 20 ft. (between ditches). This matter of the width of roadbed was about the only feature of the report that was discussed.

YARDS AND TERMINALS.

This report (which we also gave last week) was one of the most complete and business-like presented. The discussion was disappointing, however, being aimed entirely at certain changes in nomenclature proposed by the report, and the principles and questions involved in yard design and operation were not touched upon at all.

BALLASTING.

This report (see page 200 of our last issue) also brought out very little discussion, except that Mr. Lum (Southern Ry.) described the use of "chert" for railway ballast, and Mr. McDonald (N., C. & St. L. Ry.) pointed out that many roads waste money in distributing small quantities of ballast which does little permanent good.

MASONRY.

An abstract of this report is given in another column, and the discussion was devoted almost exclusively to the use of concrete in railway structures. Mr. John F. Wallace and Mr. H. W. Parkhurst gave particulars of the concrete piers, abutments, culverts and larger structures (up to 40-ft. arches) on the Illinois Central R. R. The specifications require that the cement must be delivered in time to allow for proper testing. Mr. Kittredge (C., C., C. & St. L. Ry.) has used concrete for large and small structures, but in regard to the effect of frost, he had a 10-ft. monolithic Portland cement concrete block for a crane foundation entirely ruined by cold weather (0° to 15° F.) which began the day after the concrete was laid and lasted for a week. Mr. A. S. Markley (C. & E. Ill. Ry.) mentioned similar failures of tank foundations. Mr. P. A. Peterson (Can. Pac. Ry.) did not think the use of salt in cold weather injured either the cement or the concrete. Mr. G. A. Mountain (Can. Atl. Ry.) spoke of using large blocks of stone embedded in the concrete. Another member referred to the practice of the Baltimore & Ohio Southwestern R. R. in regard to the inspection of cement for its concrete work. The cement is stored in bulk or in barrels at the mills (by special arrangement); it is inspected at the mills and shipped to the work in sealed cars, thus avoiding all delay and expense due to testing and possible rejection at the site. Plenty of time is allowed for 28-day tests at the mill. Testing costs about 7½ cts. per briquette, and sampling 1½ cts. per barrel, the latter running as high as 5 cts. for small shipments. The total cost for sampling, inspecting and testing is about 6 cts. per barrel. Mr. E. E. R. Tratman (Engineering News) referred to the general use of steel beams, rods and netting in combination with concrete, a matter which was overlooked in the report.

TIES.

This report, of which an abstract is given elsewhere, was a compilation of reports by several sub-committees. It was accompanied by records of tie renewals. Following the report, a paper on the decay of ties was read by Prof. H. Von Schrenck, of the Shaw School of Botany, St. Louis, Mo. The discussion related mainly to the preservative treatment of ties, and Mr. W. W. Curtis (Consult. Engr.) showed that little real benefit was to be expected from mere external application of the various compositions on the market. He also presented a lengthy discussion on the zinc-chloride processes which are now being extensively used in this country.

BRIDGES, TRESTLES AND DOCKS.

This report was composed of reports from three sub-committees, on Trestles, Steel Specifications, and Docks and Wharves. Mr. John F. Wallace (Ill. Cen. R. R.) opened the discussion with some consideration of the advantages of filling in trestles where this can be done without unduly reducing the waterway, and suggested steel trestles or short spans on concrete piers as a substitute for such timber trestles as cannot be filled in. Mr. Carrothers (B. & O. S. W. R. R.) said that as the result of experience with trestles of 12½ and 15 ft. bents he has adopted a spacing of 12½ ft. With the longer spans, the stringers, while perfectly safe, have too much deflection for a good riding track. Mr. T. L. Condron (Cons. Engr.) referred to the lack of uniformity in specifications for bridge steel, but disapproved of a suggestion to attempt to make American specifications uniform with foreign specifications. The discussion turned largely on the matter of uniform (not standard) specifications.

In regard to docks, Mr. W. B. Hanlon (C., L. & W. Ry.) described some ore unloading docks built by him in which metal piles are used. One of these, 640 ft. long, built in 1899, has 8-in. cast-iron gas-pipe piles, 8 ft. c. to c., 36 ft. long; it has wooden waling pieces and is tied back 30 ft. into the bank. Another dock, 790 ft. long, built in 1900, has 10-in. steel I-beams, for piles and he preferred this construction. To set the piles in hardpan, 10-in. holes were drilled for the pipe and 13-in. holes for the I-beams.

RAILS.

The general conclusions of the report of this committee are given elsewhere, with notes of the discussion. Appended to the report were the proposed rail specifications prepared by the American Section of the International Association for Testing Materials.

WATER SUPPLY SERVICE.

This committee was another of those which divided up its work among sub-committees.

From subterranean sources water is generally taken by shallow or deep wells, the former drawing supply from the immediate surface, while the latter, as a rule, go deep enough to draw from some water-bearing strata that is practically a reservoir. From the nature of the sources, the former is affected by the amount of the rainfall each season, while the latter, on the contrary, is not dependent on any one year's rains. The shallow well may be either dug, bored or driven, the particular kind being determined by the depth necessary, the amount of water to be had, and by the character of material in which it is located. It is, on account of its cheapness, the usual source of supply whenever the rains are sufficiently regular and ample. In the so-called arid region, however, the deep well is a necessity. The drilling is expensive and many holes are put down that are failures, either by yielding no water or because the water found is unfit for boiler use. In artificial ponds, water brought from streams having practically no impurities, coming directly from melting snows, has been found to be very poor for locomotive use

by causing foaming. This is possibly on account of organic matter in the reservoir. In reservoirs in the arid regions, the stored water is apt to be bad on account of the salts picked up from the soil by the rain during time of flood. Evaporation tends to increase this difficulty, and as the supply gets low the water frequently gets absolutely unfit to use in a country where ordinary bad water is considered admissible.

Track tanks become almost a necessity on a long road, crowded with heavy fast trains, saving as they do time of stops for water. From 10 to 25% as much water as goes into the tank of engine is pushed out by spout and wasted, depending upon form of spout and speed of train. They are hard to heat satisfactorily; it must ordinarily be done with steam, and generally with lack of uniformity along the tank.

The cost of pumping water varies, as the conditions are so infinitely various, in amount of water needed, kind of power available, quantity and quality of supply, etc., so that any kind of a general estimate of cost is futile; it will continue to vary from almost nothing (with water rams and wind mills under favorable conditions, pumps on natural gas lines, etc.), to the high cost of pumping by hand. The cost of pumping water by steam into a tank will also greatly vary, depending upon many things—the quantity to be pumped, the height to be lifted, the cost of coal or other fuel at the pump-house, the duty of the pump, the pay-roll at the pump-house, etc.

Many schemes have been devised from time to time to meet certain conditions, of which the submerged plant of Mr. McHenry is an ingenious instance, and several kinds of steam syphons, etc., but their usefulness is in most cases at best limited to the special conditions for which they were designed. As at most water stations special conditions will always obtain, perhaps but little more than this can be said of any other kind of machinery.

W. E. Danchy, C. R. I. & P.; D. Willard; H. C. Draper, C. & A.; O. D. Richards; W. B. Storey, A., T. & S. F.; G. H. Webster; Samuel Rockwell, L. S. & M. S.

Mr. A. S. Markley (C. & E. I. R. R.) referred to the use of filtering plants for muddy water, and to the use of gasoline engines at pumping stations. Mr. F. A. Bryan (Mich. Cen. R. R.) is using electric motors at towns where a power plant is available. Mr. J. F. Wallace (Ill. Cen. R. R.) stated that the policy on his road is now to construct reservoirs where practicable, even at great expense.

UNIFORM RULES AND ORGANIZATION.

There are two types of organization: 1, the division superintendent is in charge of the maintenance of way, as well as other operating departments on his division; 2, the division engineer (or some officer equivalent) reports direct to the chief engineer or head of the department.

Information received from 42 of the principal railways, representing a total of 95,863 miles, reveals the following facts: 23 of these roads, with 53,634 miles, have an organization in which the superintendent has full charge of the maintenance of way on his division; 19, with 40,229 miles, have an organization in which the chief engneer (or officer bearng other title, but performing similar duties) is in full charge of all engineering and maintenance-of-way matters, the engineers of maintenance of way and division egineerers reporting direct to the chief engineer.

It will thus be seen that the organization in which the superintendent is in full charge of all division matters predominates.

D. D. Carothers, B. & O. S. W.; W. J. Wilgus, N. Y. C. & H. R.; E. H. Fitzhugh, Cen. Vt.; G. A. Quinlan, H. & Tex. C.; James Oborne, Can. Pac.; T. F. Whittelsey, T. & O. C.; C. S. Churchill, N. & W.; J. T. Mahl, So. Pac.; F. B. Harriman, Ill. Cen.

The discussion on this report turned particularly on the question as to whether or not the division superintendent should be at the head of all departments on his division. The general opinion was that he should be in absolute control of all departments. Mr. John F. Wallace (Ill. Cen. R. R.) pointed out that the purpose of any system of organization should be to facilitate the business, and not to create offices. Business can best be facilitated by centering responsibility, and therefore it is best to give the division superintendents entire control and entire responsibility. The fact that the division superintendent has to report to three or four different officers on matters does not involve any division of responsibility, as the matters in question (roadway, machinery, transportation, etc.) are entirely distinct. As to expenditures, the higher officers forming the general staff would settle the allowances for the different classes of work required on each division, and leave the expending of the money to the superintendent, holding him, of course, strictly responsible.

TRACK.

The report of the committee on Track was composed of a number of papers on individual subjects by different members, and was practically not a committee report at all. There was some discussion of the paper on superelevation on curves, but Mr. A. W. Sullivan (Ill. Cen. R. R.) pointed out that the report simply presented individual opinions, and that is very far from being in accord with the aims of the association. The matters should be further investigated by the committee as a whole, and the report should not include such a quantity of material which is merely information as to the practice of different roads.

SIGNALING AND INTERLOCKING.

The subjects which the committee has considered first relate to interlocking plants. The joint use and ownership of so many plants by two or more railways makes the general adoption of like rules, specifications and standards relating to such plants a matter of considerable importance. These subjects, therefore, are of greater moment than those which pertain to the signaling of each road individually, and consequently should take precedence over those signal matters which affect each road separately.

The adoption of standard designs of signal, switch and lead-out material by most of the railways will materially reduce the number of parts to be carried in stock at joint interlocking plants and will reduce the expense of construction and maintenance of such plants.

These appliances have been developed to such a point that the adherence to certain designs can be maintained with but few changes for a considerable period. Improvements in designs will necessitate a revision of some of the plans from time to time, but the adoption of standard designs should aid in discouraging the development of unneccessary appliances which mark no advancement, but do multiply the parts to be carried in stock and thus add to the expense of the maintenance-of-way departments.

The committee has not yet come to a decision on the form of signal arm to recommend, although at least three designs are under consideration. It was the intention at first to recommend two different forms of signal-arm castings for interlocking purposes. One is designed for a 70° arc of travel and to give two indications by position; the other arm was to be designed for a 90° arc of travel and to give two indications by position. The large majority of railways employ signals, the arms of which, in the clear position, form an angle with the signal mast, this angle varying from 15° to 30° on the several roads. A few roads of prominence use the signal-arm casting design for a 90° movement, the arms pointing down and standing parallel with the signal mast when clear. The adoption of these two forms of arms would be in line with a conservative policy, for there is not a road of prominence in signal matters which could not adopt one or the other of these arms for interlocking signals and maintain the same relative positions of the arms for the indications to be given as is in vogue at present. Should the association adopt a two-position signal as standard for interlocking purposes it would be adding the weight of its authority to the inconsistent practice of having the distant signal arm for the caution indication and the home signal arm for the stop indication, both standing at right angles to the signal mast.

The only distinction made at interlocking plants between the home and distant signals for day indications is the form and color of the blades. Several roads which use two positions of the arms for giving three indications at interlocking plants, namely: "stop," "caution" and "clear," use three positions of the signal arm for giving these indications at train-order stations. It is evident that the best practice would be to have a distinct position of the signal arm for each indication to be given, and to have the indications the same for interlocking signals, train-order signals, station block signals and automatic block signals. There is no mechanical difficulty in doing this; the precedents established and the cost for making the changes are the two principal features which stand in the way of the accomplishment of this result.

H. D. Miles, Mich. Cen.; T. S. Stevens, A., T. & S. F.; C. Lewis, B. & O.; D. C. Morgan, Chi. & Alton.

The brief discussion on this report bore mainly on the relations between the work of this committee and that of the American Railway Association. The suggestion that distant signals should be put at the inclined instead of the vertical position to indicate "caution" (so as to correspond with the indications of other signals) was not adopted.

REPORTS, RECORDS AND ACCOUNTS.

This report discussed the various forms of reports and records to be kept, the track department reports, right of way maps, profiles, lease records, station plans, etc. For the accounts, the classification adopted by the Interstate Commerce Commission was recommended, with certain sub-classifications to further separate the items. The committee was composed of H. F. White, B., C. R. & N.; Joseph Morrison, Cen. Vt.; I. F. Goodale, C., B. & Q.; T. J. Frazier, B. & O.; D. MacPherson, Can. Pac.; Henry Rohwer, Mo. Pac.; Geo. Hoaliston, Pennsylvania.

There was very little discussion, but Mr. Tratman (Engineering News) referred to the desirability of reducing the number of blank forms of reports as much as possible, and making them of as few different sizes as possible, to reduce the work of making and filing the reports.

HIGHWAY GRADE CROSSINGS.

The committee on "Signs, Fences and Crossings," confined its report to the question of highway grade crossings, supplementing it with a voluminous compendium of state laws relating to the abolition of such crossings, the lighting of crossings, the use of signboards, and the sounding of bell or whistle, etc.

Of 30 roads using bells, the three that disapprove and eight that express no opinion have had a limited experience, while the 19 roads that find them satisfactory include those that have used them most extensively. The important objection to automatic bells is the possibility of failure and the increased liability of the railway when a failure leads to an accident. The bells should give at least 30 seconds' warning of the approach of any train, and be equipped with a 12-in. gong that should ring continuously when the apparatus is out of order. The number of failures is reduced by doubling the bond wires when operating by track circuit. There is a preference for gates operated by compressed air, with either pneumatic or mechanical underground connections. The cost varies from $275 per set for mechanical gates, to $300 for pneumatic gates with mechanical connections, or $325 with air connections.

When an electric railway line is crossed the consequences of an accident become very grave, but no well-settled usage or theory of protection appears to have been established. State laws do not as yet take account of this case, except in a desultory way, through the control exercised by the State Railroad Commissioners. The conditions surrounding the use of crossings of electric lines change materially from the case of the interurban line operated along a country highway and often at a rather high speed, to that of the city street-car line protected by gates and watchmen and requiring only to take account of steam trains which are being moved under control. The means adopted to avert accident can therefore be modified to suit the requirements of the case, but it is desirable that the steam railway companies should, while asserting their superior claim to the use of the crossing, accept some responsibility and demand such protection as will insure safety.

The question of how much a railway company can afford to pay to avoid a grade crossing can only be settled by the consideration of special cases. It involves the financial ability of the railroad, the expense of maintenance, the unknown element of risk, and various other conditions which are sometimes equally important.

The actual cost of constructing and maintaining a single track grade crossing with cattle-guards, etc., may be capitalized at about $300, or, if alarm bells are added, about $700. At most crossings in sparsely settled districts the average risk is indefinite, but certainly small.

D. Bontecou, K. C., F. S. & M.; C. A. Wilson, C. H. & D.; G. F. Bidwell, F. E. & Mo. Val.; I. R. W. Davis, Erie; H. J. S. Slifer, C. & N. W.; W. Shepard, Bos. & Alb.; R. Southgate, Southern.

ENTERTAINMENTS.

On March 12, a reception was given to the association at the Technical Club, the entertainment including music, singing, dancing and refreshments. A number of ladies were present. In the afternoon of March 13, a special train on the Illinois Central R. R. took the members to the South Works of the Illinois Steel Co., a box lunch being served on the train. The entire plant was visited, including the ore docks, blast furnaces, open-hearth furnaces, rail and plate mills, Portland cement mill, etc. The annual banquet was held in the large hall at the Auditorium Hotel on March 13, a very large number of members and guests being present.

MEMBERSHIP AND OFFICERS.

The Association has now 359 members, representing 140 railways, with about 175,000 miles of line. The officers for the ensuing year are as follows: President, Geo. W. Kittredge, Chief Engineer, Cleveland, Cincinnati, Chicago & St. Louis Ry.; First Vice-President, Hunter McDonald, Chief Engineer, Nashville, Chattanooga & St. Louis Ry.; Second Vice-President, A. W. Sullivan, Asst. Second Vice-Pres., Illinois Central Ry.; Secretary, L. W. Fritch, Division Superintendent, Baltimore & Ohio Southwestern Ry.; Treasurer, W. S. Dawley, Chief Engineer, Chicago & Eastern Illinois Ry.; Directors, A. Torrey, Chief Engineer, Michigan Central R. R.; Thomas Rodd, Chief Engineer, Pennsylvania Lines; Don J. Whittemore, Chief Engineer, Chicago, Milwaukee & St. Paul Ry.; F. H. McGuigan, General Superintendent, Grand Trunk Ry.; J. Kruttschnitt, General Manager, Southern Pacific Ry.; T. F. Whittlesey, Chief Engineer, Toledo & Ohio Central Ry.

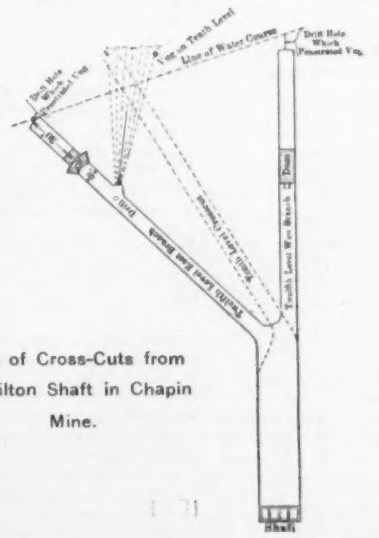
MINE DAMS.*

By James MacNaughton.†

The necessity for building mine dams throughout this part of the iron district of Michigan has been of frequent occurrence. Especially has this been true at the Chapin mine, where the principal shaft is located in the limestone and where the greater part of the cross-cutting to connect this shaft with the ore body is through limestone. During the sinking of the shaft in question, viz., the Hamilton shaft, no water of any importance was encountered until a depth of 1,460 ft. was attained, when a large water course was tapped, which filled the shaft to within 80 ft. of the surface in less than 36 hours.

The Ludington mine, adjoining the Chapin, encountered water in one of the lower levels near the limestone, which entirely flooded that mine. After these two mines had been flooded for two or three years, they were bailed out, when it was found that the inflow was no greater than that previous to their flooding. This fact would indicate that the flow causing the flooding was from a large vug or reservoir, and that when it was exhausted the inflow became normal.

In the first cross-cut from the Hamilton shaft to the Chapin ore body, which is 750 ft. from surface, a water course was encountered at a point south of the shaft in



Plan of Cross-Cuts from Hamilton Shaft in Chapin Mine.

the limestone. This water, when first struck, had a pressure of 276 lbs. per sq. in.; but by drilling several holes from the breast of the cross-cut into the water course and allowing the water to flow, the pressure, after several hours, was exhausted. The breast was blasted, and it was found that the water was flowing out through a large hole or water course in the bottom of the cross-cut. The normal flow from this point after the pressure was exhausted was 750 gallons per minute. The water course was enlarged by removing all the loose rock for a depth of 18 ft., the water being syphoned out of the vug back through the cross-cut and down the shaft to the pump, which was located at a point 580 ft. lower down in the

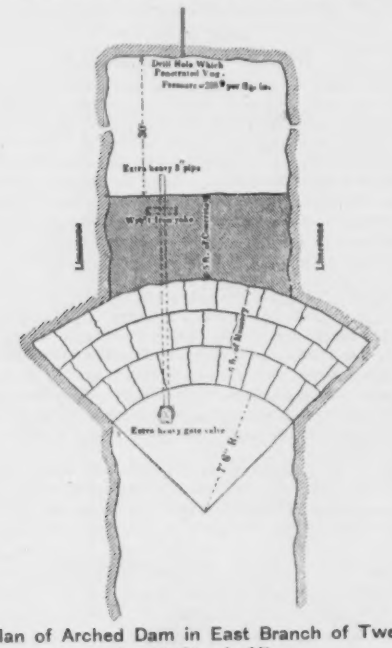
*A paper read before the Lake Superior Mining Institute and published in its "Proceedings."
†Iron Mountain, Mich.

shaft. A horizontal section of the hole after being thus enlarged, showed it to be about 7 ft. 6 ins. long by 5 ft. wide. It was inclined slightly to the west.

An extra heavy 10-in. pipe with 10-in. gate valve on the upper end was used in the vug, through which to syphon the water. A platform was made with timber around the 10-in. pipe 17 ft. below the bottom of the level. The cavity thus formed, from the platform up to the bottom of the level, was filled with a concrete composed of one part German Portland cement to two parts of sharp clean sand and four parts of broken limestone. Great care was taken in getting good contact between the concrete and the sides of the vug. To prevent leakage between the outside surface of the pipe and the concrete, the latter was not rammed tightly around the pipe, and the small crevices thus left were filled, after each foot in height of concrete had been completed, with a mixture of equal parts of sand and cement. After the entire cavity had been filled, the concrete was allowed to set for a week before the 10-in. gate valve above referred to was closed.

The entire flow of 750 gallons per minute was thus held back and in less than 12 hours the pressure on the valve had reached 276 lbs., or the same pressure as when the water was first encountered.

On the second cross-cut from the Hamilton shaft, which is 900 ft. from surface, water was encountered at the same distance south of the shaft, but at a point a little further east than on the level above. This water, like that on the first level, was struck while drilling, and showed a pressure of 355 lbs. per sq. in. The flow of water at this point was stopped by plugging the drill hole



Plan of Arched Dam in East Branch of Twelfth Level, Chapin Mine.

Thrust on dam-pressure × radius of arch. 355 lbs. × 144 = 51,120 lbs., 51,120 ÷ 2,000 = 25.56 = tons per sq. ft. 25.56 tons × 7.5 = 191.70 tons = total thrust. 191.70 tons ÷ 2 = 95.85 tons, = thrust on each skew-back. Total thrust on each ft. of height of dam = $\sqrt{(95.85)^2 \times 2}$ = 136.20 tons. 6 ft. = 72 in. × 12 = 864 sq. ins. in each ft. of height of skew-back. 864 × 6,000 lbs. (average crushing strength of sandstone used in masonry) ÷ 2,000 = 2,592 tons = crushing strength of 1 ft. of height of dam. 2,592 ÷ 136.20 = 19 = factor of safety.

with a pine plug, through which was a pipe with gate valve attached. When the plug was firmly in the hole and secured by means of braces and yokes, the valve was closed.

It soon became apparent that the breast of the cross-cut was becoming weak (there being less than 2 ft. of solid rock between the breast and the water course); and it was decided to build a dam in the cross-cut 30 ft. back from the breast to prevent any sudden inrush of water to the mine, should the breast of the cross-cut fail.

This dam was made in the shape of a circular arch on its side, the arch being 6 ft. thick and having a radius of 7 ft. 6 ins. On the crowning side of the arch, concrete to a thickness of 5 ft. was laid, this latter to act as a sealing device, while the stone arch provided the necessary strength. Local sandstone was used in the construction of the arch. A strong 3-in. pipe with gate valve on outer end extended through this dam, to carry away leakage from the end of cross-cut while the dam was being constructed. The mortar used in the construction of the arch consisted of one part of German Portland cement to two parts of sand.

When the concrete and mortar had been given a reasonable time to set, the gate valve was closed, thereby accumulating the leakage in the space between the dam and breast. As soon as this space became filled with water, the dam assumed the total load due to the height of water in the vug. The total load on this dam amounts to 1,840 tons, or 25.26 tons per sq. ft. of surface exposed.

In order to avoid the necessity of penetrating the water course encountered on this level, and also to reach by a more direct route a large ore body that was not known to exist at the time of starting the original cross-cut, a new cross-cut was started by branching off from the original one at a point some distance back from the dam last above described. When this opening had reached a point about the same distance from the shaft as the original one, only 150 ft. further west, water was again encountered while drilling. This supply was found to have the same pressure as that in the other cross-cut in this level, viz., 355 lbs. per sq. in. The efforts to stop the flow at this point did not meet with success. The breast of the cross-cut was badly broken up, many small openings or vugs being exposed, although in none of them was there any water flowing. A plug 6 ft. long, with pipe and valve, was forced into the drill hole. The valve was closed and the flow stopped, but only for a short time. The plug had not reached the bottom of the hole by 2 ft. and the rock separating the inside end of the drill hole from the exposed vugs broke away.

As it was impossible to stop the flow of water from the vugs on account of their irregular shapes, it was decided to build a dam in the cross-cut at a point 58 ft. back from the breast. While preparations for starting this dam were being made, the large bailers in the Hamilton shaft were gotten ready for use. The flow of water at this point had subsided slightly, being now only 900 gallons, which in addition to the 600 gallons normal flow at this shaft made a total of 1,500 gallons per minute to be pumped.

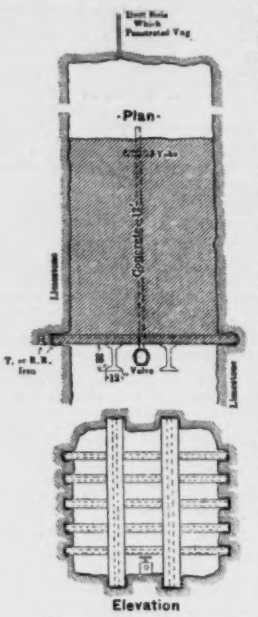
After the bailers were in readiness, an effort was made to still reduce the height of water in the vug by increasing the area of flow, and two other holes were drilled, both of them penetrating the vug. In this manner the flow was increased to 1,600 gallons per minute from this point, or a total for the pumps and bailers of 2,200 gallons. The pressure was reduced to 68 lbs. per sq. in. At this point both the pressure and flow suddenly increased, the former rising to 102 lbs. per sq. in. and the latter to almost 1,800 gallons per minute. This would probably indicate the existence of a second or parallel vug, which, by reason of the pressure being reduced in the first vug, thereby weakening the intervening wall broke through into the first vug. During 12 hours the pressure gradually reduced to 80 lbs., when there was a repetition of the occurrence, the pressure rising to 127 lbs. per sq. in. and the flow increasing somewhat, although the amount could not be determined, as the last two holes drilled were immediately plugged, and work resumed on the dam.

A temporary dam built of timber and sod was constructed near the breast. This raised the water 5 ft. high and permitted its being carried in launders past the point at which the permanent dam was to be built.

All loose rock was picked from the bottom, sides and back for a length of 22 ft. at the site of the permanent dam. After concrete to a thickness of 18 ins. and for a length of 20 ft. had been laid, an 8-in. pipe with gate valve, each capable of withstanding a pressure of 800 lbs. per sq. in., was placed centrally between the two sides, the pipe extending about a foot outside the dam at each end. Covering the inside end of the pipe was a screen, to prevent any of the sod or material incident to the construction of the temporary dam from clogging the pipe. A heavy wrought-iron yoke was used to anchor the pipe into the concrete. When the concrete had attained a height of 5 ft. and had sufficiently set, the temporary dam and launders were removed, and the flow of water began through the 8-in. pipe.

When the concrete had reached a point about 9 ins. from the back, it was discontinued. The remaining opening was filled with hard brick and cement mortar: first, because the concrete could not be properly rammed in so small a space; and secondly, to reduce the openings for cement as much as possible and thereby prevent excessive shrinkage.

There seemed no question but that this dam would stop the flow of water, provided it did not move bodily, the total load when applied being in excess of 2,500 tons. As an extra precaution lengths of 70-lb. rails were placed horizontally in the concrete with the flanges facing out and flush with the face of the concrete. The ends of these rails were cemented in hitches 6 ins. deep in each side wall. Two steel girders 13 ft. long and 32 ins. deep, with 12-in. flanges, were placed vertically so as to give a perfect bearing to the face of the concrete and flange of rails. These girders were so placed as to divide the face of the dam into three spaces of 3 ft. 4 ins. each. The girders were cemented into hitches 6 ins. deep in the back and bottom.



Plan and Elevation of Dam in West Branch of Twelfth Level, Chapin Mine.

In less than four weeks from the time the [illegible] side face of this dam had been completed, the valve was closed, provision having been made for the air existing between the dam and breast to escape through a small pipe leading to the highest point in the back near the dam.

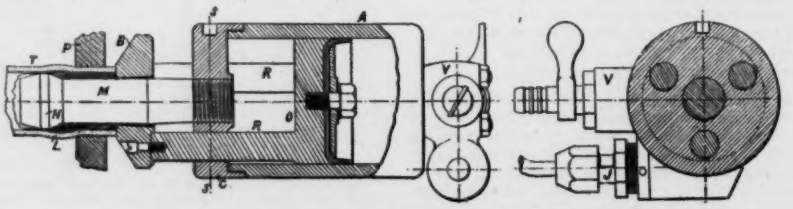
After all the air had escaped, the dam seemed to assume the load suddenly, the hand of the gage moving from 0 to 220 instantly. In six hours the pressure had reached 340 lbs., and in the course of two or three days this water resumed its normal pressure.

It is a peculiar fact that the point at which water was encountered on the first cross-cut and the two points on the second cross-cut lie in the same vertical plane.

At each of the points the water when first struck carried large quantities of fine sharp sand, and although attempts were made by building temporary dams to provide for settling before pumping, a large quantity of sand passed through the pump, to which the valves and plungers can bear evidence.

A NOVEL TUBE-EXPANDER.

The accompanying cut, which we reproduce from "Engineering" (London), shows a very ingenious device for expanding boiler tubes into the tube sheets. The essential parts are the mandrel M, one end of which is enlarged to form the head H and the bolster B. H just fits the tube which is to be expanded. It is first inserted into the end of the tube, a split lead bushing is placed about M, and B is then held tightly against the end of the tube, while the mandrel is forcibly drawn out. The lead, being confined under great pressure, flows out around H, at the same time expanding the tube. As H approaches the tube-sheet, the lead at the end of the tube is subjected to very great pressure, and the end of the tube is forced out, becoming bell-shaped. The force necessary for this operation is furnished by a small hydraulic press. The mandrel M is attached to the cylinder A, while the bolster B is attached by three rods to the piston O, which is provided with a leather packing.



Longitudinal Section. Cross Section S-S.

A DIRECT-PRESSURE BOILER TUBE EXPANDER.
Made by the Newall Engineering Co., 141 Queen Victoria St., London, E. C.

Water under high pressure being admitted into A through the valve V, B is forced against the end of the tube, while M is drawn out. The bushings are stamped from sheet-lead of 5 or 6 lbs. per sq. ft. Joints made in this way are said to have been tested satisfactorily up to a pressure of 3,900 lbs. per sq. in. Messrs. John P. Thornycroft & Co. are using the tool in their works on the construction of the boilers for four first-class torpedo-boats which they are building for the British Government. This device is the invention of Dr. C. V. Burton, of the Newall Engineering Co., Ltd., 141 Queen Victoria St., London, E. C., who are placing it on the market.